SCIENCE

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FURTHER EVIDENCE THAT CROWN GALL OF PLANTS IS CANCER[1]

TUMORS without visible cause are the subject of this address. They have been studied most numerously in man, but they occur also in the domestic animals, in wild animals (mammals, birds, batrachians, fish) and now, as we know, in plants. If this paper were given a full descriptive title it would read as follows: *Further Evidence that Crown Gall is Cancer, and that Cancer in Plants because of its Variable Form and its Bacterial Origin offers Strong Presumptive Evidence Both of the Parasitic Origin and of the Essential Unity of the Various Forms of Cancer Occurring in Man and Animals.* This is the text I shall talk to, and in passing I may add it is a view entirely opposed to the current views of cancer specialists.

To make plain what I have to say about plant tumors of this type it will be necessary briefly to mention similar animal tumors. This I shall do without special reference to medicine, *i. e.*, simply from the standpoint of a biologist, but first I shall show you the gross appearance of a few animal cancers. (Lantern slides.)

These tumors without visible cause are very common in man. They have been observed in every organ and in every tissue of every organ. They have been studied diligently by human pathologists, and especially by morphologists, for many years and there is now a great volume of literature respecting their structure and course of development, but very little is known as to

[1] Read before the Washington Academy of Sciences, May 11, 1916.

their cause,[2] and nothing as to the occurrence in them of any causal organism.

Clinically and morphologically they are divided into two well-marked groups—the benign tumors and the malignant tumors. All of these tumors, whether benign or malignant, are abnormal overgrowths (cellular proliferations) of the normal tissues of the body. Every organ and every tissue in which a benign tumor has been observed may also become the seat of a malignant tumor. Moreover, benign tumors sometimes behave like or become converted into malignant tumors. Often, in early stages of growth it can not be foretold whether a given tumor will continue benign or become malignant. Benign tumors are, therefore, always to be considered as a possible source of danger, and their interrelations, if any, with cancers can not be known until their causes are known.

As a rule, benign tumors grow slowly, although often eventually they reach a very large size, exceptionally weighing more than the rest of the body. The cells composing them approximate in form, and in size (that is in maturity), the cells of the normal tissues. Owing apparently to their slow growth, there is also a body-reaction in the form of an enveloping capsule, which shuts off the tumor from the surrounding tissues. These tumors are called "benign" because while they often cause great inconvenience and sometimes death, they are restricted, usually, to the locality where they first appear. That is, they do not develop destructive daughter tumors in other parts of the body.

On the contrary, the cancers, or malignant tumors, with a few exceptions, produce daughter tumors freely (often in vital organs), grow rapidly, are destitute of a restraining capsule, *i. e.*, become invasive, and are composed of cells, which, while showing all grades of transition, are often much smaller and more embryonic in their appearance than cells of the tissue from which they have originated, and are then most malignant. These immature cells are readily distinguished, however, from normal embryonic cells both by their disturbed polarity and by their reaction to stains. In other words, they are not genuine embryonic tissue, because they do not possess either the full structure or the entire capability of embryonic tissue. These cancer cells proliferate freely, sometimes with astonishing rapidity, invade and destroy normal tissues, and in various ways act like a foreign organism, that is, they behave in the manner of a parasite, although they are a part of the body.

Without including all of the forms known, or going into a swamping multiplicity of details, I may say that the cancers, or malignant tumors, may be subdivided into four principal groups: (1) The sarcomas, which are malignant fleshy proliferations of the various types of connective tissue; (2) the cancers proper, or carcinomas (including the epitheliomas) which are destructive (eroding) proliferations of the epithelium of the skin, mucous membrane, and glandular tissues generally; (3) the so-called mixed tumors containing proliferating elements from two germ layers, *e. g.*, the chondro-sarcomas composed of proliferating cartilage and connective tissue, the adeno-sarcomas composed of glandular tissue and connective tissue, etc.; and (4) the embryonal teratomas which, in addition to the cancerous element that is often a sarcoma, contain teratoid elements representing all three germ layers—young

[2] Dass das Dunkel auf diesem Gebiete noch nicht erhellt, des Rätsels Lösung noch nicht gefunden, das zeigt die noch stetig zunehmende Fehde der Streiter auf diesem Felde. Hie embryonaler Keim, hie parasitärer Ursprung, hie Metaplasie, hie Anaplasie, hie Anarchie, so lauten die Schlagworte der Autoren (Wilms).

tissues of various organs, frequently an astonishing mixture of teratoid elements, but all embryonic. These are also known as *atypical teratoids* in distinction from *monsters,* which are pre-natal malformations, and from *typical* (ripe or adult) *teratoids* which also are not cancers, but growths due to pre-natal disturbances, the commonest form of which is the ovarian dermoid. By Wilms they are called solid embryomas or embryoid tumors in distinction from the typical teratoids, which he calls cystic embryomas or simply embryomas.

The atypical teratoids grow rapidly, metastasize freely and are commonest in the early decades of life. In the typical teratoids the fetal fragments have grown with the growth of the host. Although dwarfed, they are as old as the individual out of which they have come, *i. e.,* they contain old skin, old teeth, old bones, long hair, etc. In the atypical teratoids the fetal fragments are always very embryonic and probably are never more than a few months old, or a few years old, no matter how old the person from whom they have been removed, *i. e.,* growth goes on in them independently of the host. Moreover, these atypical teratoids always contain cancerous elements. It is this latter type of tumor that I have recently produced in plants.

In the benign tumors, to return to animals, the tissues are arranged in a nearly or quite normal fashion and the cells are full grown, only much more abundant than they should be. In the malignant tumors the tissues are not only more embryonic, but are arranged atypically, the cells having lost a part or the whole of their polarity, *i. e.,* their orderly arrangement. Frequently, they also show defective mitosis, and very frequently polynuclear cells (the so-called "giant cells") appear, owing to fission and fragmentation of the nucleus without any corresponding cell division. Lobed and cleft nuclei are very common in cancers. They are also common in crown gall.

Cancers in addition to the malignant cells contain a stroma or framework of connective tissue and a system of blood vessels and lymph channels by means of which they are nourished, but the blood flow in these vessels is not controlled by any vasomotor nervous system. Ordinarily cancers do not contain any nerves, the associated pain being due to pressure on outside nerves.

All of these tumors are imperfectly provided with blood vessels and are subject to early decay, the resulting cavities, or open wounds, being exposed to various harmful secondary infections. In early stages of growth these tumors are purely local and may be removed surgically with good prospect that they will not return. In late stages these tumors exert a markedly detrimental effect on the whole body, which is visible as atrophy, anemia and cancerous cachexia, and surgical interference is then of little or no avail.

The daughter tumors are produced from the mother tumor in several ways, *i. e.,* by contact of a diseased area with a healthy area, as for example, by tongue against lips, or cheek against jaw; by invasive growth, *i. e.,* tumor-strands out of which the secondary tumors develop as in cancer of the breast; by motile (creeping) tumor cells; or finally, by cells or fragments dislodged by the blood stream or the lymph stream and carried to distant parts, where they multiply. The carcinomas usually invade by way of the lymphatics; the sarcomas and the embryomas, by way of the blood-vessels. When a tumor-strand can be traced from the daughter tumors back to the mother tumor they are called *invasive growths;* when no such connecting link is

visible they are called *metastatic* (or shifting) *growths*. Some modern writers, however, use the word metastasis for a daughter tumor of any origin.

As I have said, nothing is known respecting the cause of these human tumors and the great majority of cancer workers have come to the conclusion (which I believe is erroneous) that they can not be due to parasites.

It is well here to pass in review some of the objections to a parasitic theory of cancer: (1) Because many authors of distinguished reputation (Ribbert, for example) maintain that they are insuperable; (2) because so long as they are not met various persons will be discouraged from undertaking active researches designed to uncover the parasite; and (3) because, finally, if I can convince you that crown gall is a cancer, you will then be ready to admit that what requires a schizomycete for its production in the plant is not likely to be produced in any very different way in man and animals. Here then are some of the objections, and I will meet them as fairly as I can.

1. Nothing definite in the way of a parasite has been made out by use of the microscope. *Answer:* This is admitted, but it proves nothing. If we exclude the Negri bodies, still in dispute, the same is true for rabies. And in cancer we have the Plimmer bodies and other cell-inclusions of a doubtful nature, some of which may be bacterial or protozoan. The etiology of crown gall would still be in doubt if we had depended solely on the microscope, for no ordinary staining will demonstrate a bacterium in the cells, and yet it is there. For the final analysis recourse must be had to cultures and inoculations. There are then some problems in pathology which never can be solved simply by the use of the microscope.

2. From cancer no parasite has been isolated in spite of diligent bacteriological search. Innumerable cultures have been made and many inoculations and all have failed. *Answer:* The same is true of yellow fever. No parasite has been found. Until recently the same was true of syphilis. Ten years ago it was true of crown gall. There may be some very special reason (as in crown gall, or in certain types of arthritis) why isolations have failed; or the right organism may have been isolated and inoculations may have failed simply because the inoculated animals were *normal, i. e.,* fully protected by their leucocytes and therefore not susceptible. We must, I think, conceive of cancer as developing only in a weakened, unprotected condition of the body. The more or less ready growth of grafted cancer in certain animals offers no real contradiction because here the conditions are somewhat different from what they would be in case of a naked bacterial inoculation, because the grafted cancer cells are autochthonous cells and are introduced into the mouse or other experimental animal in a considerable compact mass, the inner cells shielded by the outer ones and all developing a kind of protective aura under the influence of which union with the host tissues takes place and the cancerous growth continues.

3. Heredity is a sufficient explanation. *Answer:* The same thing was said repeatedly of tuberculosis prior to 1884. Now we see that heredity furnished the canvas but could not paint the picture. Miss Maude Slye's work on heredity of cancer in mice is astonishing and praiseworthy, but I do not feel sure that a similar picture could not be obtained by breeding together tuberculous animals, indeed I am quite certain that the results of such experiments would be a vastly increased number of tubercular animals, and if we knew no more about the cause of tuberculosis than we do about the

cause of cancer, the interpretation of the results would be entirely wrong, *i. e.*, they would be ascribed wholly to heredity, whereas we know that two factors are involved: (1) heredity; (2) infection. I do not think Miss Slye has established the fact that cancer follows Mendel's law.

4. There is no need to postulate any parasite, since the cancer cell itself is the all-sufficient parasite and no cancers can be produced in the absence of this cell. *Answer:* It is strange that the authors of this statement, which has been dinned into us for a generation, can not see that it is no answer at all, but only a makeshift. As well say: Tetanus is due to tetanin. Certainly, we all admit this, but what originates the tetanin? and what originates the cancer cell? Moreover, loath as these objectors are to admit it, cancers (sarcomas) in barnyard fowls can now be induced by cancerous material all the cells of which have been removed by *filtration,* or have been killed by *heat,* by *freezing,* or by *drying* (Rous). And how should anemias and cachexias arise as the simple result of the proliferation of body cells? In other diseases they are the direct result of bacterial or protozoan multiplication in the body. In this connection reflect for a moment on what goes on in streptococcal arthritis, in persistent agues, or in yellow fever and in blackwater fever where the red blood corpuscles are destroyed wholesale. Even pernicious anemia will, I believe, be traced eventually to a blood-destroying parasite. All that we yet know definitely concerning the natural occurrence of anemias (I am purposely excluding surgical ones) is that in certain diseases they are due to blood-destroying parasites, and it is not going very far afield to assume that anemia is so produced in cancer.

5. The idea of a parasite is too complex. We know that we can graft cancer only within the narrowest limits, and also that within the same species each sort of cancer reproduces its own kind. We must therefore postulate not only as many different cancer parasites as there are animals subject to cancer, and that is probably every kind of animal, but also a parasite for every special kind of cancer in each particular animal, which is a *reductio ad absurdum. Answer:* This is a molehill magnified into a mountain—an unsubstantiated and unwarranted hypothesis! The history of science is full of such objections. Against the plainest evidence it is always easy for certain types of mind to raise objections, which then generally are left to some one else laboriously to test out experimentally, whereupon they vanish into thin air, the objections not having been well grounded. Some people are good *only* as objectors! They can not do anything concrete. It is less than twenty years since certain theoretical Germans were saying: There are no bacterial diseases of plants and can not be any, for the reasons we have given. Yet the experimental method has demonstrated the existence of nearly a hundred. In science, no theory is worth a picayune that does not have an experimental basis under it! There have been at least thirty so-called explanations of cancer origin propounded during the last half century, not one of which really explains or has any experimental basis under it. Cohnheim's theory is one of these; Ribbert's is another.

From the behavior of the cells of one species when grafted on another species we can postulate nothing as to what a naked microorganism would do under the same circumstances. As a matter of fact, plants also can not be grafted widely, yet the crown-gall organism is widely inoculable. *Moreover, it yields one result when inoculated into one set of tissues and a different result when inoculated into another set of*

tissues. In malignant neoplasms in man, and the lower animals, why then may we not assume for experimental purposes an intracellular parasite capable of producing sarcoma when infecting connective tissue cells and other types of tumor when infecting other tissues—each tissue presumptively developing according to its own type? Theoretically I can see no objection to this view, and actually we have this very thing occurring in crown gall.

6. Parasites destroy cells. They do not cause them to proliferate, and calling cancer a cell-symbiosis does not help matters. *Answer:* The world progresses and new knowledge modifies or supplants the old. Menetrier, of Paris, without knowing anything about our experimental work on crown gall, and being very sceptical as to the parasitic origin of cancer, saw clearly in 1908 (and so stated in his book) that there was no objection theoretically to assuming that in cancer there might be a parasite which did not destroy cells, but continually stimulated them to divide, only he said: What is the use of speculating, since nobody has shown any concrete example? This may have been true of that time, but it is no longer true, since there is just such a cell-parasite, or cell-symbiont, in crown gall.

7. In cancer, portions of the body grow in places where they should not, having come to the place by growth-extension from the primary tumor or having been transported there by a blood stream or a lymph stream. Nothing like this occurs in any parasitic disease. *Answer:* Formerly this statement corresponded to our knowledge, but now it does not, because just this thing occurs in the parasitic plant disease of which I am speaking, viz., invasion or growth-extension from a primary tumor resulting in the occurrence of secondary tumors in what previously were normal parts of the plant!

8. Direct stimulation of cell growth by a parasite is an unknown occurrence in biology. In all cases in which parasites are found within cells the effect is the destruction either of the parasite or of the cell. *Answer:* Antiquated information. True of many things, but not of *all.* Theoretically a third possibility exists, and actually we have it in crown gall. Here the parasitized cells are not destroyed, neither are all of the bacteria within them killed, but only most of them. There is a very delicate balance between the two, which results not in death of the host cells, but in an increased tendency to cell-division, a tendency strong enough to overcome the physiological control of the plant. When death results it is not due to the direct action of the bacteria, but to other factors, *e. g.,* nutritional defects, and secondary parasitisms.

9. Since cell proliferation in tumors is similar to cell proliferation under normal conditions, the assumption of a parasite to explain it is quite unnecessary, and makes an explanation of tumor-growth more difficult. *Answer:* Similar is not necessarily *the same.* Conclusions drawn from cultures *in vitro* do not necessarily apply to growth within the body. Cell-proliferation of tumor tissues in the body is similar, of course, to normal cell proliferation, *but with a difference,* namely, in the tumor there is an *unknown something,* which compels these cells to proliferate *in opposition to the needs of the body and in spite of the physiological body control.* Surely something very foreign to the body is required to explain the *undifferentiation,* anaplasia we call it, following von Hansemann, and the *excessive vegetative force* of the cancer cells. Moreover, so far as it is able to do so, the body treats individual cancer cells, or groups of cancer cells (metastatic fragments) exactly like parasites, that is, it envelops them in a blood clot and destroys them. In cancer, therefore, considering

what takes place in crown gall, I think we are warranted in searching for an intracellular parasite, probably some common organism, as the unknown factor, necessary to satisfy the equation and explain the phenomena. Moreover, I fail to see how the assumption of a parasite makes the explanation of tumor growth "more difficult." These objectors are here dealing with one of their many *assumptions* while I am dealing with *a fact*. I insert my infected needle and I obtain a tumor. I insert a sterile needle and the wound heals normally. Into one branch of a young Paris daisy I set my infected needle 50 times and obtained 50 tumors; at the same time into the twin branch I set a sterile needle 50 times and obtained no tumors whatsoever, but only a normal healing of the wounds. Cell proliferation *per se* in no way explains cancer. Normal cells, also, judging from the way they behave in blood serum under the microscope, must often proliferate into the plasma of the body, but such wandering cells are promptly disposed of in accordance with the law of antagonism or of physiological control, or whatever you please to call it. I mean the action of the body as a whole. Otherwise, we should have occurring continually in the body what takes place when normal tissues are cultivated *in vitro*, that is, a copious cell proliferation, which would be disastrous. This we do have in cancer, but since cancer develops in opposition to all the compelling forces of the animal body it must be owing to a profound disturbance of the normal (interior) activities of the cells involved. What is so likely as a microorganism to produce this cell disturbance leading to the formation of a tumor? Especially what, since in the plant we know that one does produce just that?

10. Cancers are due to long-continued inflammatory conditions. They begin in bruises, in old (unhealed) wounds, X-ray burns, charcoal stove burns (Kangri cancer), and various irritations and injuries incident to special trades (chimney sweeps' cancer, paraffin workers' cancer, etc.). *Answer:* The second statement is admitted. They begin in all of these places. The first statement is a *non sequitur*, a *post hoc ergo propter hoc* argument. Wounds are often infected with visible parasites, why not sometimes with invisible ones? Not all irritations end in cancers. Of two long-continued irritations one may become malignant and the other not. This is wholly inexplicable on the theory of simple irritation, but readily interpreted if we assume that cancer is due to a special and unusual kind of parasite, certain long-continued irritations having paved the way for a peculiar infection by having reduced the resistance of the body.

11. Surgeons, nurses and relatives do not contract cancer. It therefore does not behave like a communicable disease. *Answer:* Neither does malarial fever; neither does arthritis; neither does leprosy; and, finally, neither does crown gall. We must recognize that in nature there are all grades of parasitism and must be prepared to welcome forms not hitherto recognized. In pathology, as everywhere else, the open mind is after all the best asset. Closed and crystallized minds are of no further use in the world! Certainly cancer is not an acute infection, and no one regards it as such. It may be due, however, to a parasite, visible or invisible as the case may be, *some feeble parasite against which the normal body is fully protected,* some common organism, living saprophytically on the body, or in the soil, able only to infect a depleted body, and destructive only when through wounds (very slight ones, it may be) it has penetrated into the interior of certain cells, which neither kill it nor are killed by it, but

where it depresses functional activity while at the same time enormously stimulating vegetative activity. In the present state of our knowledge no one can say that this is an untenable working hypothesis. Indeed the probabilities in favor of such a view are much stronger to-day than they were five years ago, when I first discovered the cancerous nature of crown gall and began to formulate my ideas.

12. We might, possibly, concede sarcomas to be due to a parasite, but not carcinomas, and certainly not embryomas, yet whoever proposes a parasitic theory of cancer must not only demonstrate his parasite but with it must account for all of these diverse forms, and especially for embryomas, since they are the crux of the whole situation.[3] *Answer:* This is admitted. All of these forms hang together, and the claim is now made that embryonal teratomas and gland proliferations can be induced with the same schizomycete previously used to produce sarcomas. As a negation it is of no consequence whatever to say that I have only produced them in *plants,* because, little as it is yet recognized, plants are better adapted than animals to certain purposes of cancer research. In due time and in the same way, let no one doubt, they will also be produced in animals. *Whatever else may be denied, the bold fact now stands out demonstrably that all the leading types of cancerous proliferation can be produced in plants with one microorganism.* If any one doubts it, let him repeat my experiments.

13. But this hypothesis of the origin of cancers, and especially of embryonal teratomas upsets Cohnheim's theory of "cell-rests." *Answer:* It does, beyond doubt, very completely. But there is no use of making a fetish of Cohnheim's theory. It is, after all, *only a theory.* It seemed once to furnish the basis for an explanation of cancer origin, but no one was ever able to build a superstructure on it, for no one can explain why some "cell-rests" grow into cancers while others, and by far the larger number, remain dormant. We shall simply have to write *Hic jacet* over Cohnheim's theory. It serves well enough for monsters and for typical teratoids, but it does not explain cancers.

14. Plants are so unlike animals that no comparison can be drawn from diseases of the one group to those of the other group. *Answer:* On the contrary, fundamentally, plants and animals are very much alike. I mean the resemblances are much more basic than the differences. The latter, very conspicuous to the eye, may be regarded as differences of degree rather than of kind, corresponding to differences in function. Such an objection could never be raised by a biologist. It shows perhaps better than any other argument how great is the need of injecting biological concepts into cancer research. The cancer problem would have been settled long ago, I believe, had it been approached commonly from this angle rather than from that of pure morphology. Of many of the lower forms of life it is still very difficult to say whether they are plants or animals, of the whole group of bacteria, for example; and for the primitive, doubtful forms of life you will recall that Haeckel created the special kingdom of Protista. To my mind a fundamental unity runs through all living things from the lowest to the highest, like the gold thread through a tapestry! For one thing, all are *alive;* all possessed of that unstable equilibrium of forces expressed by the words *growth* and *decay.* These phenom-

[3] Gerade in diesem Punkt scheint mir die interessanteste und wichtigste Beziehung der Teratomen zu den anderen Geschwülsten zu liegen, dasz wir in den Teratomen eine Gruppe von Produkten vor uns haben, in welcher sich die Hauptfragen der Geschwulstlehre wie in einen Brennpunkt vereinigen (Borst).

ena are the properties of a substance called *protoplasm.* In both plants and animals this substance is organized into the form of cells. In both, usually, it is the outer protoplasmic membrane that controls the passage of *ions,* the disassociated electrically charged elements of water and other compounds. The same wonderful process of cell-multiplication by *mitosis* occurs in both plants and animals. In both, except in the lowest forms, these cells are organized into *tissues,* with *division of labor.* In both there is a *sexual method of reproduction.* Plants, indeed, propagate also *non-sexually by budding,* but so do many of the lower animals. In many plants there is *regeneration* when parts are cut away, but so there is in a great variety of animals. Even their foods are not different. It is true, the plant differs decidedly from the animal in possessing an apparatus for elaborating inorganic substances into starch, sugar and proteids which the animal consumes, but it makes these substances for its own use, not for the animal. It is sometimes assumed that the inorganic substances, of earth, air and water, are the food of the plant, but such is not the case. The plant depends for its growth on the same nutrient substances as the herbivorous animals, viz., on starch, sugar and proteids, which it has stored in every seed and under every growing bud. The phenomena of birth, growth and decay are essentially the same in plants and in animals; but corresponding to higher development, the animal has many special organs either wanting altogether in the plant, or greatly simplified; it also has flexible cell-walls while the plant has rigid cell-walls; but both plants and animals *respire;* both *assimilate* food substance, and *oxidize* them with resultant work; both require about the same amount of *water and mineral salts;* both have a *circulation* of fluids; and both *secrete* and *excrete* a variety of substances, acid, alkaline and neutral. The *response to stimuli,* such as gravity, heat, light, radium, X-ray, electricity and poisons, is much the same in both groups. In irritable response plants and animals both obey Weber's law (called also Fechner's law and the psycho-physic law), that is, to increase a response in an arithmetical ratio the stimulus must be applied in a geometrical ratio. There is a suggestion, even, of a nervous system in plants since stimuli are passed along certain channels to distant organs and the movement can be slowed down by cold, increased by heat or inhibited by poisons applied midway, the response, according to Bose, being not simply hydro-mechanical. Even the idea of locomotion does not distinguish animals from plants. Many of the lower animals are rooted fast, while many of the lower plants have swimming organs and are actively motile. Moreover, all of the higher plants change position more or less; all are sensitive; all show rhythmic movements. Finally, the *intimate cell-chemistry* of the two groups (production of digestive enzymes, amino acids, etc.), so far as known, is much alike. There is no *a priori* reason, therefore, why a special stimulus to cell division in plants might not prove to be of the highest interest to students of cancer in man and the lower animals. It is a matter to be taken up like any other and tested out. Researches on crown gall should have been undertaken long ago in every cancer laboratory in the world and would have been had we not unfortunately discovered a parasite. That killed the whole subject in the eyes of the orthodox! Not having found a parasite themselves, they will not believe that any one else can do it, or that there is one; and this in spite of the fact that the history of parasitic diseases from Pasteur's time down shows clearly

enough that the folly of one generation has been the wisdom of the next!

Von Hansemann has said[4] that crown gall has nothing in common with cancer except its name (Krebs). I am quite willing to let specialists weigh my evidence and decide for themselves, if only they will wake up and begin to do so! not simply ignore the whole subject because it comes to them from an unusual quarter, and is "too botanical," as another German editor said in refusing one of my papers.

In his "Principles of Pathology"[5] Doctor Adami gives the following as the characteristics of the atypical (malignant) tumors: (1) Vegetative (embryonic) character of the tumor cells; (2) rapidity of growth; (3) peripheral extension, lack of capsule and infiltration of the surrounding tissues; (4) tendency to develop metastases; (5) tendency to central degenerative changes; (6) liability to recurrence after removal; (7) cachexia; (8) anemia. All of these occur in crown gall except 4 and 8. There is nothing in the plant corresponding to blood, and the rigid cell-wall of the plant prevents metastasis in the true sense of that word. But if we use metastasis in Ribbert's loose way, then metastasis also occurs in crown gall.

One of the striking things about cancer and one separating it off sharply from all other animal diseases, is the fact that the secondary tumors are not granulomatous proliferations. That is, the secondary tumors are not a growth-response of local tissues to an irritation, and hence are not comparable to the protective granulations formed in the healing of a wound or in such a disease as tuberculosis, but they are due to the migration from the initial tumor either of infected cells or of deteriorated cells which continually reproduce their own kind to the detriment of all others. The cancer cell is a lawless entity, different in its tendencies and capabilities from any other cell of the body, and so far as we know, it always reproduces its kind, the daughter cells being cancer cells and not normal cells. Why this is so is wholly unknown in human and animal pathology, but that it is so admits of no doubt whatever. To illustrate: If medical men were able to reach into the center of tubercle nodules or syphilitic nodules in the human body, and kill the nest of pathogenic bacteria in the one case and of pathogenic protozoa in the other case, without injuring the unparasitized barrier cells forming the periphery of these nodules, then these cells would be immediately destroyed and removed from the body as no longer of use, or else would behave once more as normal body cells (scar tissue). In cancer, on the contrary, as every surgeon knows, if any cancer cells are left after an operation—even the least number—they are likely to reproduce their evil kind, in which case another tumor results either in the old locality or in some other part of the body. In other words, the outermost cancer cells are not barricades erected by the body to prevent further encroachments of the enemy, but are self-multiplying outposts of the enemy himself. However, this does not militate against the belief that some of the elements in a malignant tumor are harmless ones.

Very few laymen, I believe, have any clear conception of the exact mechanism of the cancerous process, and not a few physicians also seem to be ignorant of it. Cancers are the result of the multiplication in the body of certain body cells which have become abnormal and dangerous to the rest of the body, or as we say "cancerous," a single cell or a few cells to begin with, then

[4] *Zeitschrift für Krebsforschung*, 12te Bd., 1913, p. 146.

[5] Vol. I., p. 671.

many. Whether infected or only degenerate, these cells retain their hereditary tendencies, that is, liver cells to reproduce liver; brain cells, brain; connective tissue cells, connective tissue; and so on; but all of them while deriving nourishment from the body have become more or less emancipated from body control and exercise their freedom by an unlimited and hasty multiplication very destructive to the other tissues of the body. They reproduce their kind first in the primary tumor and later in secondary tumors. I can make this plainer perhaps by another illustration. Following tuberculosis of the lungs there sometimes occurs blood-infection and a generalized tuberculosis of every organ in the body, but in such cases the nodules wherever they arise are due to local bacterial irritation, and are always built up out of local tissues, liver tissue in the liver, spleen tissue in the spleen, and so on. In cancer, on the contrary, it is the cancer cell which migrates with all its hereditary tendencies and the secondary tumor, therefore, reproduces more or less perfectly (or imperfectly) the hereditary cell complex of the primary tumor, so that the trained pathologist after studying sections of a cancer can usually (but not always) decide whether it is primary in the organ under examination, or secondary, and if secondary, then in what other organ the primary tumor is to be sought. For example, if a primary cancer occurs in the liver and there are metastases to the lungs the *lung tumors will contain liver cells;* so if a primary cancer occurs in the stomach and there is metastasis to the liver, the liver tumor will not be formed out of liver cells *but out of stomach cells.* It is a very striking thing to see under the microscope, particularly in a well-stained section, a nest of malignant glandular stomach cells in the midst of a piece of liver. I do not know that it has been actually proved but undoubtedly such a liver tumor must have the power of secreting pepsin or at least of mucin, just as we know that metastases from a primary liver tumor into other organs may retain the power of secreting bile.

I have now come to another way in which these plant tumors resemble cancer in man and the lower animals, viz., in the striking fact that as in animals the secondary tumors reproduce the structure of the primary tumor. Thus, when a primary tumor is induced on a daisy stem by inoculation, deep-seated secondary tumors, developed from parenchymatic tumor-strands, often arise in the leaves and these tumors convert the unilateral leaf or some portion of it into the concentric closed structure of a stem. (Slides shown.)

Having now reviewed my older discoveries,[6] I come to details of more recent ones also bearing directly, I believe, on the etiology of cancer.

I have referred to the rapid growth and early decay of cancers in men and to the common occurrence of atrophy and cachexia in connection with such tumors. Similar phenomena occur in the plant. I show you three slides from photographs of galled sugar beets. They were grown in different years (1907, 1913 and 1916) but each showed the same thing, viz., sound control plants and dwarfed, sickly (yellow) and dying inoculated plants. Each inoculated plant bore a tumor larger than itself and the time from inoculation to date of the photograph varied from 2½ to 4⅕ months. This year I have obtained the same results on ornamental (white flowered) tobacco. At the end of five months all of these inoculated tobaccoes are dead or dying from large tumors of the crown, whereas the control plants are healthy, many times larger

[6] See this journal, N. S., Vol. XXXV., p. 161.

and now in blossom. To get such prompt, disastrous results, the inoculation must be fairly early in the life of the plant and near the growing point.

Secondary infections due to other organisms are also as common and as disastrous in crown gall as in cancer in man. Just now in the hothouses we have striking examples of it on the Paris daisy and I will show you a few slides. (Slides.) These secondary infections may be either fungous or bacterial.

Third, let me show you some examples of *infiltration,* taken from sunflower heads inoculated last year. The first three slides show hard greenish gray vascular tumors which have developed from a few needle pricks made into the extremely vascular thin layer which bears the seeds. The one shown in vertical section is from the middle of the flower disk and it has grown downward in the white pith for a distance of 4 inches. It lies in the pith but has not developed out of pith. The fourth slide from another tumor shows cancerous cells and vessels of the supporting stroma pushing out into the sound tissues much as roots do into a fertile soil. The fifth slide is from the cortical part of a teratoma on *Pelargonium.* Here the small-celled blastomous tissue has crowded in between coarse cells of the cortex.

Next to be considered are examples of atypical blastomous tissue taken from different parts of the same tumor (a young deep inoculation into the stem of a Paris daisy). In the first slide, at the left, is a part of the supporting stroma (cortex cells); the right side shows round cells of the same type that have become cancerous, *i. e.,* much smaller, more embryonic, rapidly proliferating, large-nucleate and deep-staining cells which have lost their polarity. The second slide shows spindle-shaped blastomous cells from the outer part of the same tumor. This tumor is the ordinary rough gall of the daisy stem, which is a sarcoma as near as the plant can make one, that is, a sarcoma minus the intercellular fibrils which are wanting in plants.

Now let us consider how plastic the living tissues can be when they are brought under a cancer stimulus. I show you photomicrographs of tumors (atypical hyperplasias) produced by inoculating the crown-gall organism into the extreme outer bark (living cortex) of young stems of Paris daisy, the inoculated cells being ordinary cortex cells. These tumor cells which conceal the bacteria (there are none in the intercellular spaces) have become more embryonic than the tissue out of which they have grown. This is shown by their size (1/20 that of the cells from which they have developed), their large nuclei and their avidity for stains, as well as by the peculiar way in which they fix the stains. It is also shown by the fact that they can produce vessels in their midst (trachei) whereas the uninjured cortex never produces vessels. The embryonic tissues of the plant, however, have this vessel-producing power. In a word, these tumor cells have become more embryonic than the tissue out of which they have developed and have lost their polarity, and this is exactly what occurs in cancer in man, as I shall show you. I have produced these superficial fine-celled hyperplasias out of coarse-celled cortex, not once, but a number of times, and in several different kinds of plants.

Thus far I have spoken only of one type of tumor, the common crown gall. Until this winter (if we except hairy root) I did not know of the existence of other types. Now I believe from what I have seen that all the leading types of cancer, viz., (1) sarcoma, (2) carcinoma, (3) mixed tumors and (4) embryomas, occur in plants and that all are due to one and the same organ-

ism. I certainly have abundant material of the end terms (Numbers 1 and 4), and enough of 2 and 3 to convince myself, if not others.

The "further evidence" alluded to in the title of this paper relates more especially to the embryomas and consists of the discovery of an entirely new type of plant tumor due to the crown-gall organism, in which tumor there are not only ordinary cancerous cells of the common crown-gall type but also entire young shoots or jumbled and fused fragments of leafy shoots and of other young organs, thus making the tumor correspond to the highest type of animal cancer, in which in addition to the blastomous element there are fragments of various fetal tissues, sometimes representing many organs of the body. This is, I believe, the first time this type of tumor has been produced experimentally, and it has been done with the bacterial organism cultured from an ordinary rough crown gall of the simpler, well-known type. It was first done by inoculating the leaf axils of growing plants, *i. e.*, the vicinity of dormant buds, in other words, centers containing totipotent cells. Some of these strange tumors have produced daughter tumors in other parts of the stem and in leaves and, as in the embryonal teratomata in man, a portion of these secondary tumors have the full structure of the primary tumor.

I have also produced these teratoid tumors in parts of plants where no totipotent cells are known to exist, but only young plastic cells normal to the parts and hitherto supposed to be able to produce only one kind of organ. This will be plainer if I say that by needle pricks introducing the bacteria locally I can now produce atypical teratoid tumors in internodes and in the middle of leaves, an astonishing discovery, and one bound, I believe, to revolutionize our views as to the origin of these tumors in man. I do not here deny that totipotent cells, hitherto unsuspected, occur in the places I have inoculated, indeed they must so occur, but I only cast doubt on their abnormal occurrence in such places, *i. e.*, as the result of early embryonic dislocations.

The belief that I have also produced "mixed tumors," that is, tumors containing distinct types of tumor cells originating from different layers of the plant, rests on stained sections of tumors from several different kinds of plants. The evidence here is not as complete as in the case of the embryonal teratoma, and I am still experimenting. What I think I have in one part of the tumor is sarcoma originating from the deeper connective tissue layers and in another part of the tumor carcinoma derived from the skin and glands of the plant. However this may be, it is now beyond question that two very distinct types of plant tumor (sarcoma and embryonal teratoma) corresponding to similar types in man, as nearly as plant tissues are able, can now be produced by bacterial inoculations, *using the same organism.* To get one type of tumor I inoculate one set of tissues, and to get the other type, another set of tissues.

Coming to the details of my newer studies, I shall first take up the question of the possible existence of carcinoma in plants, the slides I shall show you being from photomicrographs of what I consider to be "mixed tumors." All are due to pure-culture inoculations, but they show a diverse internal structure suggestive of a mixture of epithelioma (skin cancer) and sarcoma (connective tissue cancer). There is still, perhaps, some doubt as to the interpretation of these facts, so that I speak only with reserve.

The first slide I show you is from a teratoma on the common *Pelargonium* or house

geranium, but in this connection I invite your attention only to a small portion of its surface (teratoid part) where strange phenomena are in progress, quite like what often occurs in the epithelium of human teratoids. Here is a compact, small, surface tumor showing subepidermal erosion, an effort on the part of the plant to protect itself. Its deeper tissues fuse into those of the epidermis in such a way as to suggest that they have originated from the latter, *i. e.*, there are no epidermal and subepidermal differences, although these differences are conspicuous in the normal plant and also in other parts of the teratoma. In this late stage of development it is impossible to tell what may have been the origin of these queer tumors, but what appear to be much earlier stages of the tumor are visible in several places, especially on their margins, and these places exhibit, or seem to exhibit, all stages of transition between the normal one-layered faint-staining columnar epidermis (equivalent to an epithelium), and a several-layered, large nucleate, loosely arranged, deep-staining tissue, the cells of which are rounded or angular and have lost their polarity, that is, their orderly relation to their fellows. Now this is exactly what takes place in early stages of carcinoma. For instance, below the one-layered epithelium in glandular tissues of the breast, of the stomach, etc., irregularly placed, large, deep-staining, rapidly proliferating cells make their appearance as shown on the next slide, which is from a cancer of the lung. This kind of proliferation is recognized as the beginning of a malignant tumor, and surgeons base their operations on its presence or absence. If, in the breast, let us say, this displacement of cells is present, then the surgeon does a major operation, but if it is not present, then he is content with having removed only the local nodule. These surface tumors on the geranium were accidental discoveries, but I have now begun a systematic inoculation of the skins of plants to see what I can get.

I have what I believe to be the same phenomenon (a mixed tumor) on tobacco. This tumor I produced out of young cortex in 1907, but it has been properly stained and critically studied only recently. Its outer part consists of blastomous cells quite different in shape and staining capacity from the cells of its inner part. The outer cells are more or less compact and angular and the protoplasmic contents stains uniformly. The inner cells are round, more loosely arranged and stain like the ordinary sarcoma cells of this tumor. In connection with the last slide I would also call special attention to the evidence it shows of the appositional transformation of normal cells into cancer cells (atypical blastomous cells). I refer to the band of tissue lying between the normal cortex on the right (out of which the tumor has developed), and the fine-celled hyperplasia on the left. These 10 or 12 rows of cells, bordering the tumor, have the same arrangement as the tumor cells and stain deeply like those of the tumor, but are several times as large. Occasionally an unchanged cortex cell is buried in their midst. They are, I believe, a transition from the normal tissue into cancerous tissue.[7] The same phenomenon has been seen in human cancers by several good observers and there can be no doubt as to its occurrence.

Finally, from shallow bacterial inoculations done on the glands of *Ricinus* last winter I have also obtained what appears to me to be satisfactory evidence of glandular proliferations, *i. e.*, rapid multiplication of the surface layer of cells with loss of form and polarity and entrance into the

[7] See *The Journal of Cancer Research*, April, 1916, Pl. XXIII., Fig. 78.

subepidermal region as an invasive hyperplasia. The punctures were deep enough, however, to have infected the subglandular connective tissue which is also proliferating. The sections were cut at the end of 27 days and show transitions from a columnar (glandular) epidermis into an irregular, angular-celled, large nucleate, deep-staining mass of rapidly multiplying atypical cells corresponding to an epithelioma (slides). The shape of these cells is exactly that of proliferating epidermal cells from my 1/100 mm. deep 72-hour inoculations on tobacco stems. I have not yet obtained metastases from such surface growths, but I am only now beginning my studies of skin and gland proliferation and there is much to learn.

We now come to embryomas. Before describing the atypical teratoid tumors I wish to make some general remarks. Conceiving human and animal cancer to be due to a parasite, I have been greatly interested for the past ten years to see to what extent the phenomena of such cancers, the cause of which is unknown, can be paralleled by crown gall phenomena the cause of which is an intracellular schizomycete. By discovery of a tumor-strand and of stem structure in leaf tumors (in 1911) my interest received a tremendous accession from which it had not yet recovered when the newer discoveries of this winter converted it into a white heat! I am now persuaded that the solution of the whole cancer problem lies in a study of these plant tumors. At least they must now be studied until the matter is definitely settled, pro or con.

If cancer is due to a microorganism, bacterial or other, we are not obliged *theoretically* to conceive of all such new growths as due to one and the same parasite, nor, indeed, on first thought, is such the more probable hypothesis. The first thought is that probably there must be as many parasites as there are kinds of tumors, yet certainly, on further reflection, the mere cell differences between a sarcoma, let us say, and a carcinoma do not necessarily involve the conception of two parasites. The two tumors can be explained theoretically just as well by the postulate of one parasite, and in the light of our researches on crown gall much better *by one*. If the tissue response depends on the kind of cell or cells first infected, as apparently it must, on the assumption of a parasitic origin, then, of course if connective tissue cells only are involved, we shall have sarcoma; if gland cells only are invaded we shall have carcinoma; or if both, then a tumor containing both types of cancer. Whichever cell was first invaded (the bacteria being imprisoned) would be likely to continue its proliferation as a tumor of a pure type, but other elements might eventually become infected by a surgical operation, or otherwise, *e. g.*, a sarcoma might follow a carcinoma as in some mouse tumors, and also in man, the connective tissue stroma becoming infected.

I now think the human embryonal teratomata are cancerous not only potentially, but actually from the beginning. Many of them have been recognized to be so on removal, and in the remainder the stimulating blastomous portion may have remained undiscovered owing to its relatively small size, as was the case in hairy root of the apple (and every particle of such a tumor would have to be sectioned and studied before one could deny it), or it may have receded during the rapid development of the non-blastomous purely teratoid portions. All of them, whether it be assumed that they have developed from "cell-rests" or parthenogenetically, are, I believe, due to the stimulus of a microorganism, but not necessarily of a schizomycete, since other orders of parasites may,

conceivably, give rise to the same chemical and physical stimulus.

Wilms in his book on "Die Mischgeschwülste" (Heft 3, Leipzig, 1902, p. 242), if I understand him correctly, considers the blastomous portions of embryoid tumors to be of a secondary nature, as do other writers, but in this assumption they are probably wrong.

To the statements of these authors claiming the cancerous element to be secondary, may be replied: The same could be said of the shoot-producing tumors on *Pelargonium* and on tobacco did we not know experimentally that it is actually the infected tumor tissue which is the earlier and which has stimulated the normal tissues to develop. Moreover, which tissue *is* the earlier is a matter that can not be determined by mere observation of sections (Betrachtung des Wachstums—Wilms), but one to be worked out experimentally.

To condense results, I may say that during the past winter I have discovered that when the crown-gall organism (*Bacterium tumefaciens*) is introduced into the vicinity of dormant buds on growing plants atypical teratoid tumors are produced quite regularly. I have obtained these in *Pelargonium*, tobacco (2 species), tomato, *Citrus*, *Ricinus*, etc. Apparently what happens is this: The bud anlage are torn into fragments by the rapidly growing tumor and these fragments are variously distributed and oriented in the tumor where under the stimulus of the parasite they grow into abortive organs variously fused and oriented, some on the surface of the tumor, others in its depths. Surface fasciation occurs. Also in the depths of the tumors fragments of organs occur, lined by membranes bearing trichomes (hairs) and lying upside down and variously oriented and combined. The flower shoots and leaf shoots on the surface of such tumors vary greatly in number and in size, often they are the merest abortions and in that case there may be a hundred or more of them (leafy shoots or flower shoots) on a single tumor, especially on the *Pelargonium*. Even the largest and best developed surface shoots if they arise out of the tumor tissue and not from its vicinity are feebly vascularized and become yellow and dry up within a few months and often before the tumor itself decays. Such shoots never come to maturity. Immature fragments of ovaries and of anthers also occur on the surface and in the depths of such tumors.

These teratomas when produced in leaf axils on the castor oil plant reach a large size and perish quickly, *i. e.*, often within 2 months. Frequently in this plant the neighboring glands on the base of the leaf stalk are also invaded (within 2 or 3 weeks) and greatly enlarged. This is one of the striking results on *Ricinus* to which I would call special attention, since it is very suggestive of what often occurs in cancer in man, that is, of the malignant enlargement of lymph glands in the vicinity of a cancer. Following inoculations on the middle part of the leaf-blade of *Ricinus* I have also traced a parenchymatic tumor-strand down the petiole a distance of 11 cm. This was nearly circular in cross-section, large enough to be visible to the naked eye and composed of parenchyma cells. Corresponding to this were swellings on the surface of the petiole and bulging into the petiole cavity, but no ruptured tumors. No teratoids were formed on the *Ricinus* leaves.

Daughter tumors are produced freely on tobacco if the inoculations are made early enough, and these often reproduce all the teratoid elements of the primary tumor, *e. g.*, daughter tumors 10 inches away from the primary tumor may bear leafy shoots. These secondary tumors, which have been seen both in stems and in leaves, are con-

nected with the primary tumor by a tumor-strand which is lodged in the outer cortex and is vascular, *i. e.*, has the structure of a diminutive stem (stele).

What is still more astonishing, I find that I can produce these teratomas in the leaves of tobacco plants, where no dormant buds are known to exist.[8] To get these results the leaves must be fairly young, *i. e.*, plastic. They will then produce tumors where they are inoculated (needle-pricked) and many of these tumors will be covered with leafy shoots (tobacco plants in miniature). I have obtained seven such teratomas from the blade of a single leaf, and twenty-seven from the leaves of a single plant—too many to be due to Cohnheim's "cell-rests." They must have originated, I think, from groups of plastic (totipotent) cells normal to the inoculated parts of the leaves and probably also present in many uninoculated parts of such leaves, if not in all parts.

How, then, can these phenomena be explained? The teratoids I have obtained being essentially like the embryonal teratomas in animals, I believe that in both plants and animals they must have the same origin, *i. e.*, must arise from an identical chemical and physical stimulus. So far I have been able to explain the embryonal teratomas only on the assumption that in all animals and in all plants (except the simplest) certain widely distributed normally arranged cells or groups of cells, possibly all cells when very young and plastic carry the potentiality of the whole organism, which potentiality is not ordinarily developed on account of division of labor, but which comes into action when hindrances are removed, *i. e.*, when the physiological control is disturbed or destroyed. We know that life must have begun so in unicellular plants and animals and there is no good reason why it should not have continued so in multicellular ones. Only we have not been accustomed to think of it in this way, yet there are many facts respecting regeneration of lost parts in both plants and animals which coincide perfectly with this view. Coinciding with this view as to the origin of embryomas in various organs, *i. e.*, from groups of normal but very young undifferentiated or but slightly differentiated cells or groups of cells multiplying under a cancer stimulus, is the fact that I have been able to produce the teratomas in tobacco leaves only by inoculating very young leaves. When older leaves are inoculated they either do not respond or yield only the ordinary crown galls.

I may be permitted a few general remarks in conclusion, premising that this is the way the cancer problem looks to an experimental biologist.

With some praiseworthy exceptions, the cancer specialists of to-day, following the lead of the Germans, and their English imitators, are lost in a swamp of morphology, and it is time that an entirely new set of ideas should be promulgated to rescue them from their self-confessed hopelessness.

When a pathologist can say: "Concerning the ultimate nature of neoplastic overgrowth we shall never have more than a descriptive knowledge," he has reached the end of the road in his direction and the limit of pessimism! I do not care a rap whether I am called orthodox or heterodox, but I do care tremendously to keep an open mind and a hopeful spirit. One trouble with too many cancer specialists is that they are not *biologists,* whereas the cancer problem is peculiarly and preeminently a biological problem. These cancer morphologists have patiently cut and stained and studied hundreds of thousands of sections of tumors, fining and refining their defini-

[8] See *Journal of Agric. Research,* April 24, 1916, Plate XXIII.

tions and distinctions and *building up high walls of separation where nature has made none,* all because they do not understand the plasticity of living, growing things. I do not mean to condemn the study of sections, but only to suggest that there are also other ways of looking at this problem, which is one of growing things. There is too much reasoning in a circle on the part of many of these writers, too much argument basing one assumption on another assumption as if the latter were a well-established and solid fact, too little clear thinking of a biological sort, too little first-hand knowledge of living plants and animals, too much dogmatism, too much *orthodoxy,* and not enough experimentation. Hence the pessimism and the discouragement.

Cancer research was born in Germany and has been prosecuted there more diligently than anywhere else in the world, and they have done wonders in the study of its morphology, but etiologically the best the Germans have been able to do has been to cover the whole situation with a cloud of obscurity. With a few uninfluential exceptions they have denied the parasitic nature of the disease and discouraged search for an organism, and in this pessimistic attitude they have been ably seconded by their English followers. These strong men, chiefly morphologists, have dominated the situation for a generation, but they have not explained cancer and they can not explain it, and they must now give way. Indeed, from Cohnheim to Ribbert there is not one of their arguments in opposition to the parasitic nature of cancer which is not as full of holes as a skimmer!

Listen to Ribbert in his last great book:[9]

Denn wenn auch durch Mikroorganismen knotige, tumorähnliche Wucherungen hervorgerufen werden können, so handelte es sich doch stets nur um die Bildung eines entzündlichen Granulationsgewebes, das höchstens mit Tumoren der Bindegewebsgruppe eine gewisse Ähnlichkeit haben konnte (p. 378).

In other words, the most that parasites can do is to produce a granulomatous tumor superficially like a sarcoma.

Again he says:

Aber wenn das fremde Lebewesen die Zellen bewohnt, müssen diese notwendig geschädigt werden. Das folgt aus dem Begriff der Parasiten, der selbstverständlich der Zelle nur Nachteil bringen kann. Damit ist aber die den Tumor characterisierende Steigerung der Wachstumsfähigkeit der Zelle nicht vereinbar (p. 384).

In other words, when a parasite occupies a cell that cell must necessarily be injured. It follows out the very concept of a parasite that it can only bring injury to a cell, and the characteristic increase of cell growth in tumors is incompatible with this idea. Here as usual he just misses the point.

Ribbert ends his great book, of which "seine Entstehung" is its weakest part, although the illustrations are also to be criticized because they are all vague wash drawings when they should have been exact photomicrographs, as follows:

Das Karzinom entsteht auf Grund einer durch Epithelprodukte bewirkten die Differenzierung des Epithels vermindernden und sein Tiefenwachstum auslösunden subepithelialen Entzündung.

In other words, if I understand him, cancer is due to a subepithelial inflammation induced by substances arising in the epithelium, which substances cause it (or which inflammation causes it) to be less well differentiated and to grow downward. This, etiologically, is about as clear as mud!

Wilms, also, at the end of his book,[10] sarcastically inquires:

Welches Bakterium soll wohl eine Keimblattzelle, Mesoderm- oder Mesenchymzelle producieren können, die dann embryonale Gewebe und Organanlagen bildet?

[9] "Das Karzinom des Menschen sein Bau, sein Wachstum, seine Entstehung," Fr. Cohen, Bonn, 1911.

[10] "Die Mischgeschwülste," p. 275.

To which may be replied *Bacterium tumefaciens*, and probably others!

This is his additional and closing sentence designed to be a finality of invincible logic:

> Wer diese genannten angeborenen Sarkomaformen als durch Bakterien erzeugt betrachtet, übernimmt damit die Verpflichtung, auch für die Bildung seiner eigenen normalen Gewebe und Organe eine bakterielle Infektion nachzuweisen.

To which may be answered: Very well, and why not? Since a bacterial organism does just that in the plant!

I believe these old ideas and assumptions must be sifted, turned and overturned, and many of them wholly rejected if we are to find the truth.

Cancer, according to my notion, is a problem for the experimental biologist and the bacteriologist. The morphologist has gone as far as he can go and the energy of cancer research from now on must, I believe, be turned into new channels, if we are to expect results commensurate with the needs of humanity.

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ESTABLISHMENT OF A SCHOOL OF HYGIENE AND PUBLIC HEALTH BY THE ROCKEFELLER FOUNDATION

IN recognition of the urgent need in this country of improved opportunities for training in preventive medicine and public-health work and after careful study of the situation the Rockefeller Foundation has decided to establish a school of hygiene and public health in Baltimore in connection with the Johns Hopkins University, where it is believed that the close association with the Johns Hopkins Medical School and Hospital and with the school of engineering of the university furnish especially favorable conditions for the location of such a school. Dr. William H. Welch, now professor of pathology, and Dr. William H. Howell, professor of physiology in the university, will undertake the organization of the new school in its inception. The trustees of Johns Hopkins University have appointed Dr. Welch as director of the school, and Dr. Howell as head of the physiological department.

Funds will be provided by the foundation for the purchase of a site and the erection of a suitable building, in proximity to the hospital and the medical laboratories, to serve as the institute of hygiene, which will be the central feature of the school. Here will be housed various laboratories and departments needed in such a school, such as those of sanitary chemistry, of physiology as applied to hygiene, of bacteriology and protozoology, of epidemiology and industrial hygiene, of vital statistics, a museum, library, etc. Additional facilities for instruction and research will be supplied by the medical and engineering schools, the hospital and other departments of the university. Funds will be provided by the foundation for the maintenance of the school in accordance with plans which have been submitted.

It is expected that the school will be opened in October, 1917, as it is estimated that a year will be required for the construction and equipment of the institute and the gathering together of the staff of teachers.

As it is recognized that the profession of the sanitarian and worker in preventive medicine, however closely connected, is not identical with that of the practitioner of medicine and requires a specialized training, the school of hygiene and public health, while working in cooperation with the medical school, will have an independent existence under the university, coordinate with the medical school.

The school is designed to furnish educational and scientific opportunities of a high order for the cultivation of the various sciences which find application in hygiene, sanitation and preventive medicine, and for the training of medical students, physicians, engineers, chemists, biologists and others properly prepared, who wish to be grounded in the principles of these subjects, and above all for

the training of those who desire to fit themselves for careers in public-health work in its various branches. The most urgent need at the present time is provision for the training of prospective health officials and for supplementary and advanced courses for those already engaged in public health service. Satisfactory completion of work in the school will be suitably recognized by the bestowal of certificates and degrees.

It is anticipated that mutually helpful relations will be established with municipal and state departments of health and the federal public health service, whereby opportunities will be afforded for field work and other practical experience in various departments of public health work. Especially advantageous will be the relations with the International Health Board of the Rockefeller Foundation, which is engaged in the study and control, not only of hookworm, but also of malaria, yellow-fever and other tropical diseases in various parts of the world.

The influence and usefulness of the school of hygiene and public health will be extended toward education of the public by exhibits, lectures and other means in a better appreciation and understanding of the importance and needs of public and personal hygiene, in co-operative efforts for the training of public health nurses, and in other directions.

The benefits to be expected from the establishment of such a school as that contemplated will not be measured solely by the number of students trained within its walls. A far-reaching influence should be exerted upon the advancement of the science and the improvement of the practise of public health, in establishing higher standards and better methods of professional education in this field, in stimulating the foundation of similar institutions in other parts of the country, in supplying teachers, and in cooperating with boards of health and other medical schools.

ENGINEERING EXPERIMENT STATIONS IN THE STATE COLLEGES

In the Senate of the United States on March 9, 1916, Mr. Newlands introduced the following bill, which was read twice and referred to the Committee on Agriculture and Forestry.

A Bill to establish experiment stations in engineering and in the other branches of the mechanic arts in connection with the colleges established in the several states and territories under the provisions of an Act approved July second, eighteen hundred and sixty-two, and of the Acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with engineering and the other branches of the mechanic arts, and to promote the scientific investigation and experiment respecting the principles and applications of the mechanic arts, there shall be established under the direction of the land-grant college in each state or territory established, or which may hereafter be established, in accordance with the provisions of an Act approved July second, eighteen hundred and sixty-two, entitled "An Act donating public lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the Acts supplementary to said Act, a department to be known and designated as an "engineering" or a "mechanic arts experiment station."

Sec. 2. That it shall be the object and duty of said experiment stations to conduct original researches, to verify experiments, and to compile data in engineering and in the other branches of the mechanic arts as applied to the interests of the people of the United States, and particularly of such as are engaged in the industries; also to conduct researches, investigations and experiments in connection with the production, transportation, extraction and manufacture of substances utilized in the application of engineering and of other branches of the mechanic arts to industrial pursuits; water supplies as to potability and economic distribution; sewage purification and its ultimate inoffensive disposal; economic disposal of urban and manufacturing wastes; flood protection; architecture; road building; engineering problems connected with transportation, manufacturing and public utilities, and such other researches or experiments bearing directly on the various industries and occupations of the people of the United States as may in each case be deemed advisable, having due regard to the varying conditions, resources and needs of the people of the respective states and territories.

SEC. 3. That bulletins giving results of investigations or reports of progress shall be published at said stations at least once in six months, copies of which shall be sent to persons, newspapers, institutions and libraries interested in engineering and in other branches of the mechanic arts as may request same in the states and territories in which the stations are respectively located, and to others as far as the means of the stations will permit.

Such bulletins or reports, and the annual reports of said stations, shall be transmitted in the mails of the United States free of charge for postage under such regulations as the Postmaster General may from time to time prescribe.

SEC. 4. That for the purpose of paying the necessary expenses of conducting investigations and experiments, printing and distributing the results as hereinbefore described the sum of $15,000 per annum is hereby appropriated to each state and territory, to be specially provided for by Congress in the appropriation from year to year, out of any money in the treasury not otherwise appropriated, to be paid in equal quarterly payments on the first day of January, April, July and October in each year to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, nineteen hundred and sixteen.

SEC. 5. That whenever it shall appear to the Secretary of the Treasury from the annual statements of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 6. That in order to secure as far as practicable uniformity of methods and economical expenditure of funds in work of said stations the supervision of the proposed experiment stations shall rest with the Secretary of the Interior.

It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the state or territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of the other stations provided for in this Act, to the Secretary of the Interior and to the Secretary of the Treasury of the United States.

SEC. 7. That nothing in this Act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the states or territories in which they are respectively located.

SEC. 8. That nothing in this Act shall be held or construed as binding the United States to continue any payment from the Treasury to any or all the states or institutions mentioned in this Act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this Act.

This bill, appearing to be an important measure for the advancement of research, the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science has adopted the following resolutions:

WHEREAS the applications of science have made democracy possible by so decreasing the labor required from each that equal opportunity can be given to all;

WHEREAS in a democracy scientific research, which is for the general benefit and can not usually be sold to individuals, must be supported by the public;

WHEREAS a combination of national and state support and control is desirable in education and in research and its value has been fully proved by the Land Grant Colleges of Agriculture and the Mechanic Arts, established in the states and territories by the Congress in 1862;

WHEREAS there is in connection with each of these colleges an agricultural experiment station to which the national government appropriates annually $30,000 for agricultural research, the results of which have been of untold value to agriculture and to the nation;

WHEREAS experiment stations for the mechanic arts and engineering, including in their scope research in physics, chemistry and other sciences, would be of equal value to the nation and would repay manyfold their cost, and

WHEREAS at the present time attention is directed to the need of preparation for every emergency, and this can best be accomplished by the advancement of science and the ability of our people to meet new conditions as they arise;

Resolved that the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science earnestly recommends the passage of the senate bill introduced by Mr. Newlands to establish experiment stations in engineering and in the other branches of the mechanic arts in connection with the colleges established by the Congress in the several states and territories,

with an annual appropriation to each of $15,000 for conducting investigations and experiments and printing and distributing the results; and further

Resolved that the committee urges each of the ten thousand members of the American Association for the Advancement of Science to use all proper efforts to bring the importance of the measure before members of the Congress and to the attention of the public.

J. McKeen Cattell,

June 20, 1916

SCIENTIFIC NOTES AND NEWS

Dr. William J. Mayo, of Rochester, Minnesota, has been elected president of the American Medical Association, in succession to Surgeon General Rupert Blue, U. S. N.

Dr. A. B. Macallum, professor of physiology in the University of Toronto, has been elected president of the Royal Society of Canada.

Professor William J. Beal, formerly professor of botany at the Michigan Agricultural College, has received the degree of doctor of agriculture from Syracuse University.

Three degrees of doctor of laws were conferred at the recent commencement exercises of the University of Missouri at Columbia, as follows: Curtis F. Marbut, graduate and former professor of geology in the University of Missouri, now in charge of the national soil survey organized by the U. S. Department of Agriculture; Henry Jackson Waters, president of the Kansas State Agricultural College, a graduate and former dean of the agricultural faculty of the University of Missouri; and Roscoe Pound, dean of the Harvard University School of Law.

Professor Edwin G. Conklin, of Princeton University, will give the William Ellery Hale lectures at the autumn meeting of the National Academy of Sciences.

Sir Arthur Evans, F.R.S., will preside over the eighty-sixth annual meeting of the British Association for the Advancement of Science to be held at Newcastle-upon-Tyne on September 9. The following are the presidents of sections: A (mathematical and physical science), Dr. A. N. Whitehead; B (chemistry), Professor G. G. Henderson; C (geology), Professor W. S. Boulton; D (zoology), Professor E. W. MacBride; E (geography), Mr. D. G. Hogarth; F (economic science and statistics), Professor A. W. Kirkaldy; G (engineering), Mr. G. G. Stoney; H (anthropology), Dr. R. R. Marett; I (physiology), Professor A. R. Cushny; K (botany), Dr. A. B. Rendle; L (educational science), Rev. W. Temple; M (agriculture), Dr. E. J. Russell.

Sir David Prain, director of the Kew Botanical Gardens, has been elected president of the Linnean Society.

Dr. Emil von Behring, professor of hygiene at Marburg and director of the Institute of Experimental Therapy, has for reasons of health retired from active service.

Dr. L. H. Bailey has assembled the addresses delivered by him as vice-president of Section M (agriculture) of the American Association for the Advancement of Science, which were published in Science, and two others of similar character, and published them privately under the title "Ground Levels in Democracy." He offers to send the booklet free, as long as the supply lasts, to persons interested, upon application to his home address, Ithaca, N. Y.

Professor Herbert E. Gregory, of Yale University, who has been spending the winter in the Australian deserts, has returned to New Haven.

The International Health Commission of the Rockefeller Foundation sent to Brazil to make a general medical survey of the southern part of the country, has returned. The commission consisted of Professor Richard M. Peirce, of the University of Pennsylvania, chairman; Major Bailey K. Ashford, of the U. S. Medical Corps; Dr. John A. Ferrell, of the International Health Commission, and a secretary. They were absent for about four months and the work included a study of the general educational system in Brazil, the medical schools, hospitals and dispensaries, and public health organization.

THE Carnegie Institution expedition to Tobago, British West Indies, was exceptionally successful. The southwestern end of Tobago consists of elevated coral-bearing limestones and the coast from Milford Bay northward is flanked by a modern coral reef. Dr. Herbert Lyman Clark, of Harvard University, collected 73 species of echinoderms in this region, and of these Dr. Th. Mortensen, of Copenhagen University, reared 10 throughout their larval stages; among them a crinoid Tropiometra which was abundant over the shallow reef-flats. Dr. A. G. Mayer studied the Siphonophores, the pelagic life being abundant, due to the fact that the water of the great equatorial drift of the Atlantic strikes immediately upon the coast of Tobago. The coastal waters of Tobago are those of the clear blue tropical ocean, for the island lies to the northward of the muddy shores of Trinidad.

N. S. AMSTUTZ, of Valparaiso, Indiana, recently gave an illustrated lecture on the "Marvels of Illustration" during an afternoon meeting at the Bureau of Standards, Washington, D. C., and in the evening before the Association of Federal Photographers in the new National Museum.

Two Harvard graduates and a member of the junior class in Harvard College will leave this month on an expedition to South America for the Harvard Museum of Comparative Zoology. The party, consisting of Dr. L. S. Moss, of Baltimore, a graduate of the medical school; Dr. C. Tello, a Harvard graduate who is now living in Lima, Peru, and G. K. Noble, '17, of Yonkers, N. Y., will sail from New York for Paita, Peru. From this point they will cross the Andes and into the Amazon Valley. The purpose of the expedition is to collect zoological specimens and to study the native tribe of Guarani Indians.

SIX physicians and six nurses, comprising the sixth medical relief expedition to be sent from the United States to the Central Powers under the auspices of the American Physician's Expeditions Committee, have left New York on board the Holland-American line steamship *Ryndam* for Rotterdam, whence they will proceed to Austria. The party is headed by Dr. Joseph Irilus Eastman, of Indianapolis, professor of surgery in the University of Indiana.

THE Royal Society has awarded to Miss Dorothy Dufton, of Girton College, Cambridge, the first year's income of their Lawrence Fund, for an investigation of pneumonia produced by poisonous gases. The income of the Lawrence Fund, about £160 a year, is devoted to research in the relief of human suffering. Miss Dufton is the daughter of Dr. S. F. Dufton, inspector of schools in Leeds, and is doing research work in Cambridge University Physiological Laboratory.

UNIVERSITY AND EDUCATIONAL NEWS

THE magnificent new buildings of the Massachusetts Institute of Technology, on the Cambridge side of the Charles River, were dedicated last week with imposing ceremonies. At the formal dedicatory exercises on June 14, addresses were made by President Richard C. Maclaurin, by President A. Lawrence Lowell, of Harvard University, now allied with the institute, by Governor Samuel W. McCall, and by Senator Henry Cabot Lodge.

THE tenth annual report of the Carnegie Foundation for the Advancement of Teaching, published on June 19, shows that the income from general endowment was $697,892, and the expenditures $712,852. The income from the endowment of the Division of Educational Enquiry was $50,300, and the expenditures $54,633.

AT the commencement exercises of Wesleyan University the Van Vleck Astronomical Observatory, the gift of the late Joseph Van Vleck, of Montclair, N. J., was dedicated.

To represent the faculty of Cornell University as delegates at the meeting of the board of trustees, the following have been elected: Dexter S. Kimball, professor of machine design and industrial engineering; Walter F. Willcox, professor of economics and statistics, and John Henry Comstock, emeritus professor of entomology and general invertebrate zoology.

MR. ERNEST MARTIN HOPKINS, until 1910 secretary of Dartmouth College and since en-

gaged in business in Boston, has been elected president of the college, to succeed President Ernest Fox Nichols, who has resigned to accept a chair of physics at Yale University.

At the University of Nebraska, Dr. David D. Whitney, now at Wesleyan University, Middletown, Conn., has been appointed professor of zoology, in charge of courses in the fields of genetics, evolution and experimental zoology. Homer B. Latimer, now professor of zoology in Nebraska Wesleyan University, has been appointed associate professor of zoology, in charge of work in vertebrate anatomy, embryology and histology.

George Frederic Ordeman, Ph.D., has been elected associate professor of chemistry, and Robert William Dickey, Ph.D., associate professor of physics in Washington and Lee University.

At Sibley College, Cornell University, the following instructors have been promoted to the grade of assistant professors: Clarence Andrew Pierce, in power engineering; Myron A. Lee, in machine design, and John George Pertsch, Jr., in electrical engineering. Joseph Franklin Putnam has been appointed assistant professor of electrical engineering. He has been professor of physics in St. John's College, Shanghai. Frederick George Switzer has been appointed instructor in the mechanics of engineering.

Vera Dantschakoff, M.D., of the Rockefeller Institute for Medical Research, has been appointed instructor in anatomy, and Rosalie F. Morton, M.D., as attending surgeon at Vanderbilt Clinic of the College of Physicians and Surgeons of Columbia University.

Recent additions to the faculty of the University of Arkansas are J. Sam Guy, Ph.D. (Johns Hopkins), head of the department of chemistry, succeeding the late Dr. C. G. Carroll; F. G. Baender, M.S. (Cornell University), formerly assistant professor in the University of Iowa, head of the department of mechanical engineering; P. B. Barker, late of the agricultural faculty of the University of Missouri, head of the department of agronomy. Arthur M. Harding, Ph.D. (Chicago), returns to the university, after a year's leave of absence, as professor of mathematics and university examiner.

DISCUSSION AND CORRESPONDENCE

CORAL REEFS

To the Editor of Science: In his article on "Coral Reefs" in the April *Scientific Monthly*, Professor Davis gives an abridged and distorted version of Alexander Agassiz's theory, thus setting up a dummy to be conveniently knocked down. A careful consideration of *all* the forces suggested by Agassiz as contributing to the formation of atolls and barrier reefs should convince Professor Davis that the hypothesis calls for neither cliffs, deltas nor talus on the islands enclosed by barrier reefs. For the ring of living corals breaks the force of the waves; and the great quantities of water piled over the reef by the trade winds forms a gigantic modified pothole which scours out the material eroded from the island. Professor Davis has stated that any theory would account for the formation of atolls and barrier reefs themselves. He appears to forget that it was because many investigators in the field were unable to reconcile the facts observed with the theory of subsidence that led them to suggest other explanations. Any one at all familiar with the methods of work of both the elder and younger Agassiz would never think of quietly assuming that either was ignorant of the literature of his subject.

G. R. Agassiz

ANOTHER POISONOUS CLAVICEPS

The results of the experiments by Brown and Ranck, showing the poisonous action of *Claviceps paspali* Stevens and Hall on animals, published in Technical Bulletin 6, Mississippi Agricultural Experiment Station, has just been received by me and read with unusual interest, as I have followed the history of this interesting fungus since 1902.

I first noticed the disease produced by *Claviceps* very abundant and conspicuous on *Paspalum læve* in Maryland in the summer of 1902, and in the autumn of the same year a sample of it was received from a Maryland

farmer who had taken it from a field where cattle had died with symptoms of poisoning. The similarity of these sclerotia to the common ergot gave further indication of its probable poisonous character and a quantity of the diseased grains was collected for testing, but no animals were available at the time and learning from Professor P. H. Rolfs that he was working on the life history of the fungus (as recorded by Stevens and Hall when they published descriptions of the two *Paspalum* ergots in the *Botanical Gazette* in 1910) the matter was dropped. There was, however, a short note on these observations published in my report on plant diseases in Maryland in 1902, in the Maryland Horticultural Society Report for 1902, as follows: "A fungus disease causing the seeds of a wild grass (*Paspalum lævе*) to expand and break open like popcorn has been abundant and has been suspected of being poisonous to cattle."

Since then a few cases of stock disease, sometimes confused with the well-known but yet little understood "horse disease," have occurred in Maryland, where the *Paspalum* ergot was abundant enough to be suspected and, judging from the experimental results so well worked out in Mississippi, was without much doubt the cause of the trouble.

The *Claviceps* sclerotia which replace the *Paspalum* grains are frequent in Maryland nearly every year, though in some years almost absent and sometimes, as in 1915, unusually abundant.

J. B. S. NORTON
AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

NAMES OF CELESTIAL ELEMENTS

I WISH to learn the name of the giver and first place of publication of the following: Neptunium of Mendeléef, cited by Biclok and Martin; Coronium (the same as Mendeléef's "x"), said to be by Huggins; Helium, Aurorium and Nebulum (or Nebulium), the last two cited by Crookes, presidential address Brit. Ass. 1898. Any one who can give me any one of the citations will confer a favor upon the subscriber.

B. K. EMERSON
AMHERST, MASS

QUOTATIONS

ENGINEERING EXPERIMENT STATIONS IN THE LAND GRANT COLLEGES

ON July 2, 1862, President Lincoln approved the act establishing the Land Grant Colleges of Agriculture and the Mechanic Arts, and on March 3, 1863, he approved the act incorporating the National Academy of Sciences. When the nation was stricken down with civil war it sought relief in science, on the one hand, establishing institutions for the scientific education of all the people in the arts of peace, on the other hand, recognizing exceptional merit in science and making the most distinguished men of the country the advisers of the government.

Now when the world is again infected by war more terrible than can be imagined in this one great nation which has escaped, we are naturally driven to think of "preparedness," and it will be well if this movement can be directed to making the nation strong through education and scientific research. At least three bills are before the Congress which are more important for the welfare of the country and its defense from foreign aggression, should that ever become necessary, than any enlargement of the army and navy. These bills would establish a national university, extend secondary education in industry and agriculture, and establish research stations for engineering at the college of agriculture and mechanic arts.

A national university at Washington, holding the same position toward the state and privately endowed universities as these hold or should hold to the colleges and schools of each state, would correspond with the establishment of the National Academy of Sciences during the civil war, but could be made far more effective in its influence on research and on the efficient conduct of the departments of the government.

The Smith-Hughes bill provides for the promotion of the vocational education of boys and girls of high-school age through cooperation of the nation and the states. There is appropriated for the first year $1,700,000 with an increment each year for eight years on condition that each cooperating state shall appro-

priate an equal sum. In the first year the sum of $200,000 is for administration and investigation, $500,000 for training teachers for vocational work, and $1,000,000 for payment of teachers, equally divided between agriculture, on the one side, and trade, home economics and industry, on the other.

Of special interest to scientific men is the Newlands bill establishing research stations in engineering, corresponding to the existing agricultural stations in the colleges of agriculture and the mechanic arts. These land grant colleges and their agricultural research stations have been of incalculable value to education, to agriculture, to the states and to the nation. They have been largely responsible for the establishment and development of the state universities. The land grant colleges and the institutions of which they are a part received in 1914 from the United States $2,500,000; from the states and from other sources over $30,000,000. They have 9,000 instructors and 105,000 students.

By the Hatch act of 1887 and the Adams act of 1906 the sum of $30,000 a year is appropriated for research in agriculture in the experiment stations. The colleges have more students of mechanic arts than of agriculture, but there is no similar provision for research in the mechanic arts and engineering, and the sciences, such as physics and chemistry, on which they are based. The agricultural interests have always had great influence on legislation and in this case they have led the way. It is to be hoped that research in the engineering sciences will now be equally encouraged by the passage of the Newlands bill, which appropriate $15,000 to each state and territory for conducting investigations in engineering and publishing the results.

Some scientific men may believe that more could be accomplished by the establishment of one great research laboratory or by granting the money only to institutions already distinguished for their contributions to science. There is, however, much to be said for initiating investigation in fifty widely scattered centers where work is already being done in agricultural science. It brings the value of research to the attention of the students of the college and the people of the state, and each station has the possibility of great development. In any case the passage of the bill as it stands is the most feasible method at present to extend research and will forward rather than interfere with other methods.—*The Scientific Monthly.*

SCIENTIFIC BOOKS

The Mathematical Theory of Probabilities. By Arne Fisher, F.S.S. Translated and edited from the author's original Danish notes with the assistance of William Bonynge, B.A., with an introductory note by F. W. Frankland, F.I.A., F.A.S., F.S.S. New York, The Macmillan Company. Vol. I. Pp. ix + 171.

Although a considerable number of standard text-books on probability have appeared in recent years in foreign languages, there is a lack of such books in the English language. Both on this account and because of the selection of subject-matter, the present book should be particularly useful. Research work in the theory of probability has received during the past twenty years a new impetus, through the labors of certain mathematical statisticians. In this connection, we may perhaps mention particularly the work of Pearson in England, Lexis in Germany, Westergaard in Denmark. Each group of investigators seems to have moved along its particular line. In the present work an attempt is made to treat these researches from a common point of view based on the mathematical principles grounded in the work of Laplace, "Theorie analytique des Probabilites."

The introductory chapter consists of a brief discussion of the general principles and philosophical aspects of a theory of probability. Here, in the determination of what events are to be regarded as "equally likely," both the principle of "insufficient reason" and the principle of "cogent reason" are illustrated, and the inference is drawn that a compromise of the two principles gives us a valuable meaning of "equally likely." Then follow some interesting historical and biographical notes.

The definition of mathematical probability from which are developed the elementary theorems of probability is quoted from Czuber, and is about the usual definition of *a priori* probability. The author is rather emphatic in his criticism of the idea of replacing the *a priori* probabilities of Laplace by the empirical ratios of Mill, Venn and Chrystal. He believes the distrust of *a priori* probabilities is due to a misapprehension of the true nature of Bernoulli's theorem, which is the cornerstone of the theory of statistics. The chapter on probability *a posteriori* deals with the criticisms of Bayes's rule in a rather constructive manner, by indicating the limitations under which Bayes's rule will give correct results in practise. The author makes the connection between *a priori* probabilities and statistical series by the use of the well-known theorem of Tchebycheff. In this connection he offers a proof that the limit of a relative frequency a/s when s becomes infinite is the postulated *a priori* probability p. It seems to the reviewer that the notion of limit here employed is not quite the rigorous notion; for, the statement that the probability that $|a/s - p| < \delta$ approached 1 as a limit, is not the same as the usual statement that $|a/s - p|$ becomes and *remains* less than δ. The author does not seem to discriminate in this connection between a point of condensation and a limit point.

One of the most interesting and important parts of this book is its neat and striking applications of Bernoulli, Poisson and Lexis series to the characterization of actual data. Furthermore, the application of the Lexian ratio and of the Charlier coefficient of disturbancy is clearly shown. Taken as a whole, this book will be found of much value to students of the mathematical methods in statistics.

H. L. RIETZ

Gould's Practitioner's Medical Dictionary. Third edition, revised and edited by R. J. E. SCOTT, M.A., B.C.L., M.D., of New York. Pp. xx + 962. Flexible cloth, round corners, marbled edges. P. Blakiston's Son & Co., Philadelphia. Price $2.75.

The history of medical dictionaries begins with the fifteenth century. The first works of the kind are the "Synonyma" (Venice, 1473) of Simone de Cordo or Simon of Genoa and the contemporary Pandects of Mathæus Silvaticus. Both these works are alphabetical lists of medicinal simples, but a goodly number of real medical dictionaries were published during the Renaissance period, in particular those of Lorenz Fries or Phryesen (1519), Henri Estienne or Stephanus (1564) and Jean de Gorris (1564).

In the seventeenth century appeared the famous "Lexica" of Bartholommeo Castelli (1607) and Steven Blancard (1679) which passed through many editions. After these the number of medical dictionaries is legion. Among the best known of more recent times are those of Robert James (London, 1743) and P. H. Nysten (Paris, 1810), which, in 1855, was entirely rewritten by Emile Littré and Charles Robin and is still a standard source of reference. In England, the dictionary of the New Sydenham Society (1878–99), in America that of Frank P. Foster (1888–93), and in France, Galtier-Boissière's "Larousse Médical illustré" (1912), are monuments of scholarship. Gould's large illustrated medical dictionary (1894), frequently revised and reedited, has been of great practical use to the medical profession. Of late years the tendency has been towards handy volumes of reasonable thickness, printed on thin paper, with flexible covers, and of these the new edition of Gould's Practitioner's Dictionary is an excellent example.

This new edition is unsurpassed as to comprehensiveness, clearness and size. It contains over 70,000 words. To reduce the size of the book and to make it a handy volume a small type had to be selected, but the type is very clear and legible and is even a little larger than that used in Webster's Unabridged Dictionary. Each word is accompanied by its pronunciation and followed by its etymology. The definitions are clear and concise.

The book contains all the numerous and latest eponyms in their proper alphabetical order, such as Abderhalden's test, Alzheimer's disease, Lane's kink, Meltzer's method,

Schlatter's disease. An important feature is the large number of new words with which the medical vocabulary has been enriched during the last few years. The book contains such new words as anoci-association, biometer, colliculectomy, gassed, keritherapy, leukotoxic, serobacterins, sympathoblasts, etc.

This handy, practical book, in octavo size, 1¼ inches thick, containing nearly 71,000 words, is unique among modern dictionaries and can not fail to receive a hearty welcome by the medical practitioner and the student of medicine.

A. Alleman

Army Medical Museum

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

(Volume 2, Number 5)

The fifth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The High Frequency Spectrum of Tungsten:* Albert W. Hull and Marion Rice, Research Laboratory, General Electric Company.

The authors show two photographs of the spectrum of X-rays taken in the usual manner in a rock-salt crystal. They also give figures which show the ionization current as a function of the angle of incidence. A comparison with previous results obtained by others is sketched.

2. *On the Foundations of Plane Analysis Situs:* Robert L. Moore, Department of Mathematics, University of Pennsylvania.

As point, limit-point and regions (of certain types) are fundamental in analysis situs, the author has set up two systems of postulates for plane analysis situs based upon these notions; each set is sufficient for considerable body of theorems.

3. *A General Theory of Surfaces:* Edwin B. Wilson and C. L. E. Moore, Department of Mathematics, Massachusetts Institute of Technology.

Continuing the work of Kommerell, Levi and Segre, a theory of two-dimensional surfaces in n-dimensional space is developed by the method of analysis outlined by Ricci in his absolute differential calculus.

4. *Dynamical Stability of Aeroplanes:* Jerome C. Hunsaker, U. S. Navy and Massachusetts Institute of Technology.

A comparative detailed study of two aeroplanes, one a standard military tractor, the other designed for inherent stability, is made for the purpose of reaching general conclusions of a practical nature with respect to aeroplane design. It appears that inherent stability (except at low speed) can be obtained by careful design without departing seriously from the standard type now in use.

5. *Cliffed Islands in the Coral Seas:* W. M. Davis, Department of Geology and Geography, Harvard University.

The author extends his former work on the Origin of Coral Reefs to include the explanation of the cliffs of exceptional reef-encircled islands of which no adequate explanation has previously been given.

6. *On Some Relations between the Proper Motions, Radial Velocities and Magnitudes of Stars of Classes B and A:* C. D. Perrine, Observatorio Nacional Argentino, Cordoba.

The velocity distribution of classes *B*–*B*5 and *A* differ from the distributions found for the *F*, *G*, *K* and *M* classes by Kapteyn and Adams.

7. *Asymmetry in the Proper Motions and Radial Velocities of Stars of Class B and Their Possible Relation to a Motion of Rotation:* C. D. Perrine, Observatorio Nacional Argentino, Cordoba.

Stars of class *B* show differences in the proper motions in the two regions of the Milky Way at right angles to the direction of solar motion; the differences appear to be best explained by a general motion of rotation of the system of stars in a retrograde direction about an axis perpendicular to the Milky Way.

8. *Theory of an Aeroplane Encountering Gusts:* Edwin Bidwell Wilson, Department of Mathematics, Massachusetts Institute of Technology.

The longitudinal motion of an aeroplane encountering head-on, vertical, or rotary gusts is discussed by the method of small oscillations.

An inherently stable machine striking a head gust of J feet per second soars to altitude of about $4\frac{1}{2}$ J feet above its initial level and, after executing oscillations, remains about $3\frac{1}{2}$ J feet above the original level.

9. *Terms of Relationship and Social Organization:* TRUMAN MICHELSON, Bureau of American Ethnology, Washington, D. C.

From the point of view of Algonquian tribes terms of relationship are linguistic and disseminative phenomena, though in other cases they may be primarily psychological and sociological.

Report of the Annual Meeting: Prepared by the Home Secretary.

This report has appeared in full in SCIENCE.

EDWIN BIDWELL WILSON
MASS. INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

THE SCALES OF THE GONORHYNCHID FISHES

THE Gonorhynchidæ constitute a small family of very peculiar marine fishes of elongate form, found in the seas about Japan, Australia and South Africa. In the Eocene deposits of Wyoming is a fish which Cope named *Notogoneus osculus,* considered to belong to the Gonorhynchidæ. Whitfield in 1890[1] gave an account of a specimen of this species, and expressed the opinion that it belonged in the vicinity of the suckers, or Catostomidæ. It seemed remarkable that a fish from a fresh or brackish water deposit in Wyoming should be referred to a rare marine family of a remote region of the earth; and the scales of *Notogoneus,* admirably figured by Whitfield, did not at all resemble those of the Isospondylous fishes in general, neither had they any resemblance to those of the Catostomidæ. Wishing to apply the more exact methods of comparison of later times, I asked Dr. D. S. Jordan for scales of *Gonorhynchus,* and he has very kindly sent material from *G. abbreviatus* Schlegel, obtained by Alan Owston in the Yokohama (Misaki) market, Japan. These scales wholly confirm the reference of *Notogoneus* to the Gonorhynchidæ, and afford a remarkable illustration of the constancy of scale-structure through millions of years and migrations over the earth. The long parallel-sided scales of *G. abbreviatus* are narrower than those of *N. osculus,* and the truncate base is crenulate, but the peculiar structure is entirely the same. The apical margin has a single row of 18 or fewer (never so many as in *N. osculus*) teeth, which are long and stout, and connected by a thin lamina. Just below these is a broad sculptureless band, the same in living and fossil forms. The lateral circuli are strictly longitudinal and not very dense. Spreading fan-like from the subapical nucleus are the radii (about 12), closely set, with longitudinal bands of curved lines, derived from the system of circuli, between them.

Jordan and Snyder[2] say of *G. abbreviatus:*

> Mr. E. C. Starks has examined the shoulder girdle of this species; it has the mesocoracoid arch, as usual with Isospondylous fishes. Its place is apparently with the earliest and most generalized of these forms.

The scales, however, are more like those of Acanthopterygians. Coming to details of structure, we find a striking resemblance to the scales of *Aphredoderus,* of which genus Jordan says: "Probably the most primitive of all living Percoid fishes, showing affinities with the Salmopercæ" (to which group Regan has more recently referred it). *Aphredoderus* has the same type of marginal teeth, though there is no hyaline band beneath them and the radii are few. Marginal teeth of the same type are found in another group, little related to *Aphredoderus* or *Gonorhynchus;* namely, the Characiform genus *Distichodus* of the fresh waters of tropical Africa. The rest of the *Distichodus* scale shows no close resemblance to that of *Gonorhynchus.*

We have, then, evidence of the extreme constancy of scale characters, even minute details, in the Gonorhynchidæ. On the other hand, the most striking feature of the Gonorhynchid pattern appears, not in the presumed allies of that family, but in other families supposed to be very far removed from it. Is this wholly a matter of independent evolution,

[1] *Bull. Amer. Mus. Nat. His.,* III., p. 117.

[2] Smithsonian Misc. Coll., 45 (1904), p. 236.

or did the Gonorhynchids early develop a type of scale-structure which has survived here and there in remote descendants? The actual origin of this type of scale may date back of the Gonorhynchids, but it is nevertheless a specialized structure, which in the absence of evidence to the contrary would be thought to be of relatively recent origin.

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ANTHROPOLOGY AT THE WASHINGTON MEETING

IV

The European and the American Child: Paul R. Radosavljevich.

On the basis of a summary study of 50,000 Europeans and 50,000 American school children, represented by various European and American authors, it is shown that the most important factors are: (1) age, (2) sex, (3) race; and the least important are (4) school brightness, and (5) environment. The general average values of these measurements for both European and American pupils are very much alike, the difference being most evident in their variations. American pupils vary more than their European brothers and sisters at all the school ages studied (5–20 years). Hebrew children show the greatest variation; then Anglo-Saxon; then Latin, and least variation is shown by Slav pupils. If we take in account, however, not the variation based on general arithmetical averages, but on individual cases of such racial groups, then we see that the difference in the variation (or distribution) of one group, say the Slavic group, is greater than the difference of variation between two groups.

This variation, however, is not uniform for all measurements: that for body heights and weights is the greatest, while that for the two common head diameters is the least. This might be due, of course, to the inaccuracy of measurements, or to the statistical treatment, or to the personal equation of the investigators, or to the collective method of taking the measurements, etc., or to all of these factors. It is, therefore, for the present at least, very hard to accept many of the conclusions derived from these data, for it is an established fact that a mere statistical interpretation of these results is not *eo ipso* a biological-anthropological possibility, nor, furthermore, that such a possibility carries with it a pedagogical necessity.

Pedagogical Anthropology in the United States: Paul R. Radosavljevich.

Physical anthropology of pupils in the United States is beginning to develop along scientific lines, both in regard to the method of collecting data and in describing and explaining these inductive facts. The purpose of school anthropometric investigation in the United States has been based on all kinds of criteria, but not on primarily scientific-pedagogical criteria. These criteria might be grouped into (*a*) statistical-correlative (Boas, Bowditch, Porter, Peckham, Byer, Macdonald, West, Baldwin, *et al.;* (*b*) hygienic-comparative (Sargent, Hitchcock, Seeley, Seaver, Crampton, Fuld, Smedley, Hastings, *et al.*); (*c*) pathological-comparative (Wyley, Bar, Goddard, *et al.*).

Scientific anthropological criterion in the study of physical traits of children and youth is suggested in the works of Dr. Aleš Hrdlička and B. A. Gould, who combine the spirit of three great European schools in pedagogical anthropology (Meumann-Martin school in Germany, Godin school in France, and Sergi school in Italy). This criterion might be called biological-pedagogical, a criterion which has been more or less propagated among educators by G. Stanley Hall's "Adolescence," and the recently translated Montessori's "Pedagogical Anthropology," the only two general books on pedagogical anthropology published in the United States.

The future of scientific pedagogical anthropology in the United States will depend largely on the establishment of (*a*) an anthropological-pedagogical museum, (*b*) an anthropological-pedagogical laboratory, and (*c*) special academic chairs for pedagogical anthropology, the scientific discipline of which will be binding on all those who are studying education, psychology, sociology and criminology.

The Comparative Convolutional Complexity of Male and Female Brains: E. E. Southard.

The material for the study consists of brain photographs (six views of each brain) in the collection of the Massachusetts State Board of Insanity, derived from over 500 brains in the possession of various state and private institutions of Massachusetts, including so-called "normal" brains and brains from a variety of psychopathic subjects. The method of the study is numerical, based upon counts of fissures and fissurets. The results, so far as interpretable, show no great sex difference in degree of fissuration.

Oracles of the Saints: PHILLIPS BARRY.

Divination, prohibited by decrees of early ecclesiastical councils, was not suppressed, but remained an important by-product of popular religion. Some effort was made by a lax clergy to establish a Christian technique in divination.

Divination by opening the Scriptures at random and taking as an oracle the first verse to meet the eye, originated with St. Augustine, persisted in spite of imperial and canon law, and is not yet extinct.

The "Oracles of the Saints"—a manual of divination for use of Christians, going back to the sixth century, may be shown by documentary evidence to have been compiled from catalogues of oracular texts used in local pagan temples—an evidence of the historic continuity between pagan and Christian divination.

Use of letters of the alphabet in divination, widely current in the Middle Ages, is of pre-Christian origin, and may be traced to the usage of Egypt-Greek magic and mystical cults.

Ballads Surviving in the United States: C. ALPHONSO SMITH.

Ballad singing is not a lost art, since 77 of the original 305 ballads are still sung in the United States and about 85 in Great Britain. In the recovery of the ballad in the United States, the South leads, Virginia reporting 36. Communal composition may be best illustrated by the camp-meeting songs of the southern negroes. "The Hangman's Tree" (No. 95) is popular among the negroes of Virginia as an out-of-doors drama. A comparison of ballad tunes shows greater variety than of ballad texts. American ballad tunes and American ballad texts may be older than their surviving parallels in Great Britain. They may go back to textual and melodic variants, which not only antedate the surviving British variants but which in some cases left no lineal British issue. A comparison, for example, of seven musical arrangements of "Barbara Allen," one from Scotland, one from England, and five recently transcribed from the lips of singers in Virginia, no one of whom understood music and four of whom were from the same county, proves that the differences are so great that neither the British nor the Scotch melody can be claimed as the original. A new field of comparative song is thus opened. (This paper appeared in full in *The Musical Quarterly*, edited by O. G. Sonneck, New York and London, January, 1916.)

Pan-American Topic: ABRAHAM ALVAREZ.

After a brief consideration of the importance of the study of the archeology of the American continent, the author proposes as a means of conserving the pre-Columbian monuments the following plan:

Article I. The American governments agree to establish a museum of American anthropology and archeology, which shall be called "Pan-American Museum."

Art. II. In this museum there shall be collected: (*a*) American antiquities, (*b*) mummies, (*c*) stuffed specimens of animals existing in the different countries from the time prior to the conquest to the present, (*d*) specimens of native plants, (*e*) native minerals, (*f*) collections of books relating to the ancient plans, photographs, chromolithographs and detailed descriptions of all the monuments and ruins of the pre-Columbian epoch, (*h*) maps of the respective countries showing the location of each race or tribe and the position of the ruins, (*i*) phonographs with records of the speech and songs of the Indian languages for the purpose of preserving said languages, (*j*) studies of all the native races, (*k*) studies of the different native languages.

Art. III. The ancient ruins shall be preserved and cared for by each government. They shall not be sold or given away or disposed of in any other manner. They shall be the property of the nation.

Art. IV. Each museum shall send to the other Pan-American museums reports of the anthropological and archeological work done during the year within its jurisdiction.

Art. V. All the objects to which Article II., section (*a*), refers shall be property of the state and should be placed in the museum, whatever may have been the place they were found.

The Desirability of Uniform Laws throughout the Pan-American Countries for the Encouragement and Protection of the Study of Archeology and Anthropology and the Collection of Material Relating to these Sciences: MAX UHLE.

The American nations have had only four centuries of existence on this continent. They lack, therefore, the long history which usually gives to other peoples strength and power of resistance in times of stress such as those through which all the nations of America have had to pass. The lack of a long national history must be made good by the study of the peoples, who occupied the territory before the time of Columbus. From this study lessons may be drawn applicable to national de-

velopment of the present time. The study of the pre-Columbian period in the Western Hemisphere must be based on the sciences of archeology and anthropology. The American governments have not yet recognized the importance of these two sciences as a means for deepening their knowledge of American history, and thus is to be explained the absolute neglect of the monuments and other archeological materials constituting the necessary basis for the study of the history of the pre-Columbian epoch. On account of this complete neglect the documents which existed on the surface of the earth and beneath the soil—documents which must serve as the source for the study of early American history—have unfortunately already been largely destroyed or removed from the American continent. It is, therefore, urgent that better protection should now be given the ruins that remain.

During the century of the conquest the peoples constituting the existing nations occupied the whole continent. There was thus formed a kind of historic unity, which implies the duty of studying the pre-Columbian period, as well as that of the later period. The cooperation of all the countries in this common task is all the more necessary, because, notwithstanding numerous points of difference, the continent appears to have presented a historic unity from the earliest times up until the development of the great native civilizations. The solution of the common historic problems is impossible unless all the countries advance along this line with equal step. It is, therefore, desirable that an agreement should be entered into by the different countries for the purpose of protecting the vestiges of antiquity within their respective territories in their own interest and in the common interest. The best way to accomplish this end is by means of appropriate uniform laws in all the countries.

The Study of the Convenience of Uniform Laws in all the American Countries, to Protect and Stimulate the Collection of Anthropological and Archeological Material and Data, and to Encourage the Study of the Same: Samuel Lainez.

In this report the author considers carefully the importance of the study of American anthropology and archeology; he examines the great problems of these sciences and their solution; indicates the work of investigation effected up to the present time and what is yet to be done in this vast field, and as a result of his study formulates 13 propositions with a view to stimulating and protecting, by means of uniform laws in all the American nations, the investigations whose object is the collection and study of anthropological and archeological material and data.

Service of the Academy of Natural Sciences of Philadelphia to American Anthropology: S. G. Dixon.

Anthropology excited the interest of the earliest naturalists in America. The first contributions to American anthropology show that among the earliest members of this institution were those who took an active part in American anthropology. True to the traditions of the older natural science institutions, the Philadelphia Academy shows by its publications that man was considered as an animal to be studied structurally. One of the first contributions to the subject was the great collections of human crania presented by Dr. Samuel G. Morton, which has been supplemented by Meigs and others. The collections of the academy have furnished material for important papers by Morton and the late Dr. Harrison Allen, besides many other students of anthropology.

Among the contributors to the literature of the subject are Brinton, Gabb, Halderman, Holmes, Hrdlička, Leidy, Meigs, Moore, Morton and Putnam. One of the lines of work of a substantial character done by the academy consisted in furthering the Arctic expeditions of Kane, Hayes and Peary, the last mentioned adding to our knowledge of the Greenland Eskimo. The Philadelphia Academy maintained a chair of anthropology for many years under Dr. Daniel G. Brinton. The Philadelphia Museum is rich in ethnographic and archeological specimens. Collections gathered by famous expeditions, beginning in 1805 with Lewis and Clark, were followed by Keating, Poinset, Meittal, Townsend, Rusemberger, Sharp, Gabb and Peary; but the most comprehensive of all have resulted from many expeditions of Clarence B. Moore, whose archeological collections from the southern states have no parallel.

The Archives of the Indies: History of and Suggestions for their Exploitation: Roscoe R. Hill.

The Archives of the Indies, founded at the close of the eighteenth century, is one of the richest collections of materials for colonial history in existence. Successive and proposed additions from Madrid and Simancas will make the collection cover completely the colonial history of the former oversea dominions of Spain.

The earliest use of the Archives was made by Muñoz for his "Historia del Neuvo Mundo," and by Navarrete for his "Colección de los Viajes y Descubrimientos." A more pretentious exploitation, aided by a subsidy from the Spanish government, resulted in the two series of the "Colección de Documentos Inéditos." This work was carelessly done, but serves to indicate the extent and richness of the Archives.

Extensive investigations have been made in settling boundary disputes of the Latin-American republics, and many documents have been published in this connection. Several governments, notably Argentina, Chile, Ecuador, Dominican Republic, Mexico and Cuba, at various times have commissioned individuals to study and make collections of documents for the history of their respective countries.

The exploitation by the United States has been carried on by private individuals or by institutions, like the Carnegie Institution or the universities of Texas and California. This has confined itself to describing and copying documents.

A suggested plan for further exploitation is based on international cooperation. Each of the American republics should have a director in Sevilla, and these should form a board or faculty for exploitation. Scholarships or fellowships should be maintained by the American governments and universities. The directors should supervise the studies of the scholars, and direct the investigation, cataloguing, copying, editing and publishing the documents relating to their respective countries.

The Origin and Various Types of Mounds in Eastern United States: DAVID I. BUSHNELL, JR.

The Indian mounds of the United States east of the Mississippi (this does not include effigies and inclosures) may be divided into three classes, namely: burial, ceremonial and domiciliary. Burial mounds are the most numerous; they form large groups in the area north of the Ohio, and near by are often traces of a former village; they are usually rather small, circular in outline, and, on examination, reveal burials of various types. But such mounds, isolated or in groups, are widely scattered over the valley of the Mississippi and eastward.

Ceremonial mounds are less easily distinguished. The term should, however, be applied to mounds covering altars, and those which bear evidence of sacrifices, such as have been discovered in the valley of the Ohio and elsewhere. The great Cahokia Mound was probably the site of a temple, and for this reason it, as well as others of this type, may be considered as ceremonial structures.

Domiciliary mounds or platforms are those erected as elevated sites for habitations, or which resulted from the accumulation of camp refuse during a long occupancy. They are met with in Florida and along the low banks of the southern rivers. These often served also as places of individual burials.

The discovery of many objects of European origin in some mounds, more especially those in the southern states; the many references in the works of early writers to the use of mounds by the Indians with whom they came in contact; and the nature of the burials encountered in the northern mounds, which correspond with the known customs of the tribes whose homes were in the neighborhood of these groups, prove that mounds were still in process of erection at the time of the coming of Europeans, but the practise ceased soon after.

The Amazon Expedition of the University of Pennsylvania: GEORGE BYRON GORDON.

The Amazon Expedition was sent out for the purpose of procuring data respecting the relationships of the different tribes in the Amazon valley and in the southern Guianas. The first investigation occupied six months in an unexplored territory between the Guianas and Brazil. Here a number of new tribes were located and extensive data, linguistic and ethnological, were obtained. Each of the tribes was identified as belonging linguistically either to the Arawak or to the Carib stock. On the Ucuyali in the Peruvian Amazon, a number of obscure tribes were similarly studied and their relationships determined. The third region explored was the plain between the Tapajos and Xingu rivers, inhabited by the Mundurucus, whose central villages were visited for the first time by Dr. Farabee, the leader of the expedition.

This latter exploration proves that the great plain above mentioned is a barren waste instead of the fertile grazing land which it was supposed to be. The principal anthropological result of this exploration is the definite identification of the language of the natives with the Tupi stock.

The Ruins of Yucu-Tichiyo: CONSTANTINE G. RICHARDS.

Outside of the places where once stood the palaces of the principal chiefs of the Mixtec and the residence and temples of their priests, namely,

Tilantonge and Achiutla, little is known of the many other ruins found in the Mixtec country. Among these are the ruins of Tucu-Tichiyo. Even here little is now left of what at one time must have been an important center, and the author puts on record some views of the structures before the walls shall all have crumbled and nothing but mounds remain. Remarks were made on the country where the ruins are to be seen, followed by a description of the buildings and mounds still standing. Information from old natives was given, as well as some measurements of the buildings, and what has been found in the course of the limited excavations that have been made.

A Study of Family Names in Chile: Luis Thayer Ojeda.

The present study is composed of four chapters. The first treats of the history of surnames, studying their evolution and their origin from the time when they have merely the form of personal names through to their transformation into generic family names.

The second chapter consists of the etymological classification of family names. From this point of view the author divides the surnames of Chile into seven groups, as follows: Individual, geographic, historic, abstract, combined, doubtful and foreign. The author notes that these groups may be divided and subdivided into related classes.

In the third chapter the author gives the morphological classification of surnames in three groups, as follows: Perfect names, comprising all the Spanish surnames whose orthography is in conformity with that indicated by the Royal Museum; imperfect names, including Spanish surnames which have suffered alterations; and foreign names which embrace all the surnames belonging to other languages.

In the fourth chapter an ethnological classification of surnames is made, arranged by countries in which the names have originated.

In the fifth chapter, after certain considerations, the author arrives at the conclusion that surnames may be an efficient aid in determining the ethnic compositions of countries. The study made of 167,400 names has served as the basis for a calculation of the proportion of the different races which inhabit Chile.

On the Glenoid Fossa of the Eskimo: V. Giuffrida-Ruggeri.

In a recent bulletin of the Canadian Department of Mines, Knowles directs attention to the peculiar form of the glenoid fossa and articular eminence in Eskimo skulls. The fossa is shallow, while the articular eminence is flattened and extended in a forward direction. Having read this notice in *Nature*, June 17, 1915, I immediately wrote to the author, asking for the extract, but up to the present I have received no answer. I think that surely only a small percentage of Eskimo skulls really present such an anomaly, for were it a common conformation it would hardly have escaped notice; but anthropologists who have previously studied collections of Eskimo skulls have never noted the observance of such a peculiarity. On the other hand, this anomaly is not peculiar to the Eskimo, as I remarked on its recurrence, seventeen years ago, in Italian skulls. The publication of my article led to further extensive research in the Anthropological Museum of Florence and a detailed article was published on the subject by R. Polli in 1899.

Mongoloid Signs in Some Ethnic Types of the Andine Plateau: Arthur Posnansky.

A study of certain somatic signs observed by the author in some of the ethnic types of the Andine Plateau, and believed by him to be characteristically Mongolian.

The signs observed are: (1) The Mongolian fold (*pliegue mongolico*) in the countenance of some Indians; (2) the *os japonicum* in certain crania; and (3) the Mongolian spot (*mancha mongolica*).

The author says that it is impossible to determine the percentage of the Indians of the plateau having the Mongolian fold, since there are groups who do not possess it at all, while others show it without exception. Certain tribes of the Chingu River had it in a not very marked degree; but the author has observed it in a more pronounced form in the Paumari and Ipurina Indians on the river Pirûs and on the lower Acre (Brazil). The fold develops as the individual develops, disappearing completely in old age, a phenomenon observed in the Mongolian race also. This characterictic fold is found among the Eskimos, and the Botacudos of Brazil. The author has examined in Europe a thousand crania of Mongolians and an equal number from the pre-Columbian mounds of the Andine Plateau; and in both he found a pronounced *sulcus* in the maxillar or the region of the *procesus frontalis*, and in the *dacryon* (lachrymal region), situated a little above the *piriformis* opening. As this *sulcus* does not appear in anatomical nomen-

clature, the author has called it the *Sulcus Mongolis*. The author believes that the *pliegue mongolico* is motived by the above mentioned *sulcus*, which is found with more or less marked intensity in the crania of the Mongolian races and in some subraces of the Andine Plateau. In the cranium of the European it is so imperceptible that the anatomists up to the present time have had nothing to say about it.

With reference to the *os japonicum* the author says that in a series of 20 crania from Tiahuanacu he found a specimen of the *os japonicum dextrum*. The author has classified this cranium as *dolichocephalic*. A characteristic of this cranium consists in the *procesus marginales dextr. et sinistr.* being greatly accentuated. It is also marked by the persistence of the frontal suture. On account of the lack of facilities, the author was not able to determine the frequency of the *os japonicum* in the crania of the Andine Plateau.

The Mongolian spot (*mancha mongolica*), which has been considered up to the present time as a characteristic mark of the Mongolian race, is found also, according to the writer, with extraordinary frequency on the bodies of Indian children and adults of the Andine Plateau. In certain regions the spot is found in 92 per cent. of the children of pure Aimara (Colla) and Quechua races. The color of the spot is generally purple or greenish blue. It covers the large part of the buttock and extends to both sides of the spine.

Curves of Physical Growth of the School Children of La Paz, Bolivia: GEORGES ROUMA.

This report is composed of five parts, as follows:

The methods used in establishing the curves of growth of the school children, and the importance of its application to the school children of the capital of the republic of Bolivia.

The program which was followed in carrying out the investigations of the physical development of the school children.

The technique employed in the investigations.

A series of graphs showing the results of the measurements taken in La Paz.

General consideration relative to the physical development of the school children of La Paz.

Concepts of Nature among American Natives: ALICE C. FLETCHER.

A broad view of the concepts held by the tribes of this continent makes it evident that to the American natives the cosmos was a living unit, similar to a family, and permeated by a mysterious, unseen, life-giving power which had brought nature into being and provided for its perpetuation through the dual (masculine and feminine) forces. Sky and earth are their simplest representatives. Each section is made up of parts and each part partakes of the function of its section.

Man is not regarded as a distinct creation, but as an integral part of nature, deriving his physical and psychical existence from the same mysterious power that animates all other portions of the cosmos. Many tribes have given this power a specific name which is held in reverence. This power was the object of worship in the tribal rites, in which symbols of animal and psychical forces were widely used, but nowhere did these symbols take on a human form. Tribal rites were primarily religious and were fundamental to the tribal organization which aimed to reflect the concept of the cosmos and man's relation to it. Secular government was subordinate to tribal rites.

To the mysterious power certain human qualities were ascribed, as order, truthfulness, justice, pity. The right to govern was also attributed; the punishment of falsity and wrong-doing. These anthropomorphic ascriptions were never fully carried out and crystallized among the native Americans, as was done on the eastern continent.

The belief that all things were alive and could affect the physical and psychical life of man was also common to both hemispheres. The expessions of this belief on the two continents afford material for an instructive comparison.

Two Notes on Spanish Folklore: G. G. KING.

The author mentions two points of Gallegan use in connection with corn: (1) All through Galicia the granaries are topped with a cross at one end and the ancient emblem of fertility on the other. (2) In August, before the corn is ripe, she found a fresh yellow ear saved from the harvest, hung on a wayside cross.

A variant from Navarre of the folktales of the bird's song that seemed three minutes and three hundred years passed.

Comparative Study of Pawnee and Blackfoot Rituals: CLARK WISSLER.

Since the Pawnee data used in this study are still unpublished, a brief characterization of Pawnee rituals will be given. Then it will be shown that there are very striking parallels between the Blackfoot and Pawnee. This holds both for the rituals themselves and for the bundles with which they are associated. So far as the data for the upper

Missouri village tribes are available, they seem to place them as intermediate between the Pawnee and the Blackfoot. When we consider the distribution of these traits in the Plains area it appears that rituals of the Pawnee-Arikara-Blackfoot type are but weakly developed in neighboring tribes, though strongest among the Siouan neighbors of the Pawnee. Also ritualism is most intense among the agricultural tribes and weakest among those strictly non-agricultural. The suggestion is, therefore, that the Pawnee are the approximate center for the dispersion of this trait in the Plains.

The second peint is a comparison of Pawnee ritualism with tribes in other parts of the continent. We find certain parallels to Pueblo rituals as associated with maize culture and a specific Mexican parallel in the human sacrifice.

A Manuscript by Rasmus Rask: The Aleutian Language Compared with the Greenlandic: William Thalbitzer.

The famous Danish linguist, R. K. Rask, who in 1818–19 stayed at Saint Petersburg on his journey to India, met there two natives of the Aleutian Islands, who had accompanied the expedition of Otto V. Kotzebue on his return from Bering Straits. Rask took the opportunity of recording some specimens of the Aleut language, which he spelled in his usual way and accompanied with a Danish translation, with some additional comparative remarks on the Aleut and Greenland languages. Thus Rask was the first to discover some points of resemblance in the grammar and vocabulary of these languages. This manuscript, which contains about 200 Aleut words, was never published, however, and remained unknown to later explorers of the Aleutians. After the death of Rask, in 1832, the manuscript was deposited in the Royal Library at Copenhagen. It will now be submitted for publication in the *Proceedings* of the Congress, translated into English, being probably the earliest modern contribution to American linguistics made by one of the founders of the present comparative science of languages.

PAPERS PRESENTED FOR WHICH NO ABSTRACT WAS PROCURED

(1) "The Oldest Known Illustrations of South American Indians"; (2) "Present State of our Knowledge of the South American Indians; with a Linguistic Map," by Rudolph Schuller.

(1) "Origin of the Indians of Central and South America"; (2) "Lexicology of the Names of the Indian God," by J. A. Caparo.

(1) "An Inca Road and Several Hitherto Undescribed Ruins in the Urubamba Valley, Peru"; (2) "Some Extraordinary Trepanned Skulls Found this Year in the Urubamba Valley, Peru"; (3) "The Inca Peoples and their Culture," by Hiram Bingham.

"Notes on the Folklore of the Peruvian Indians," by F. A. Pezet..

"The Domain of the Aztecs," by A. M. Tozzer.

(1) "The So-called Pelike Type of North Argentina Pottery"; (2) "Scarifiers of Northwest Argentina," by Juan B. Ambrosetti.

"Cayuga Ownership of New York Land," by Grace E. Taft.

"Eye and Hair Color in Children of Old Americans," by Beatrice L. Stevenson.

"New Methods in Ethnographic Photography," by Frederick I. Monsen.

"What the United States has done for Anthropology," by F. W. Hodge.

(1) "The Pre-Columbian Indians of the Eastern Extremity of Cuba"; (2) "Discovery of the first Indian Sepulture of Cuba," by Louis Montané.

"Observations on Some Shell Mounds on the East Coast of Florida," by Amos W. Butler.

"The Indians and their Culture as Described in the Swedish and Dutch Records of 1614 to 1664," by Amandus Johnson.

(1) "The Diffusion of Culture, a Critique"; (2) "Totemic Complexes in North America," by A. A. Goldenweiser.

"Chronological Relations of Coastal Algonkin Culture," by Alanson Skinner.

"Excavations in the Department of Peten, Guatemala," by Raymond E. Merwin.

"The Rise and Fall of the Maya Civilization in the Light of the Monuments and the Native Chronicles," by S. G. Morley.

"The Archeology and Physical Anthropology of Teneriffe," by E. A. Hooton.

"Early Graves of Nasca Valley, Peru," by Julio C. Tello.

"Origenes Etnograficos de Colombia," by Carlos C. Marquez.

"Archeological Explorations in Mexico," by Manuel Gamio.

"The Racial Factor in Delinquency," by Dr. Thomas Williams.

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